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SPE APPROVES

(Story on page 11)

Statement of Principles by the Plastics Industry

PLASTIC materials challenge industry with new concepts of design, engineering, construction, processibility and usefulness.

The properties of plastic materials, when correctly used, open up great new areas of service to industry and the public.

Improper use can do irreparable damage to the plastics industry, to both manufacturers and processors of the materials.

Therefore, we as manufacturers and processors of plastic materials reaffirm our adherence to the principles upon which the healthy growth of a great industry depends and undertake to:

I. Understand thoroughly the properties and limitations of all plastic materials handled by us.

II. Apply the correct plastic materials to all industrial end uses, designing and engineering them for maximum value, performance and safety.

III. Use great care to select the correct plastic materials for all consumer items, designing and engineering them to insure value, satisfaction, safety and pleasure to all users.

IV. Sell plastic materials, and all industrial and consumer items made therefrom, on the merits of the materials, applications and design, and free of extravagant, unsupportable claims.

All to the end that plastic materials already available, and others that may come, will bring to industry and public alike all the benefits, economies and satisfactions inherent in these versatile engineering and construction materials.

Accepted

Manufacturing Chemists' Association, Inc.
William C. Foster, President

The Society of Plastics Engineers, Inc.
John A. [illegible], President

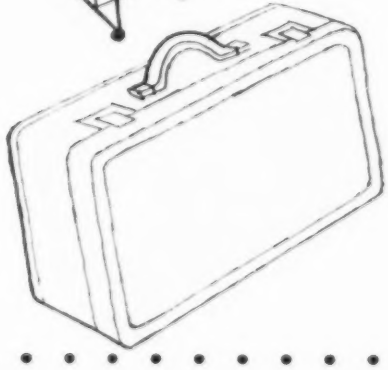
The Society of the Plastics Industry, Inc.
[illegible] O'Connell, President

Plastic Coating and Film Association
[illegible], President

PUBLISHED BY THE SOCIETY OF PLASTICS ENGINEERS, INC.

NEW... from Monsanto

for casters, coaters, slush molders



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Developed especially for coating, casting and slush-mold applications, Monsanto's new Opalon 410 plastisol resin offers an exceptionally wide range of *outstanding* properties you can use to advantage.

It is an extremely versatile resin of absolute uniformity . . . with low viscosity and good dispersion. It can be stirred into other components in a high-speed mixer . . . needs no solvent addition . . . requires no grinding.

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2. **Resistance to grease, water and most detergents**
3. **Resistance to oxidation and discoloration by sunlight**
4. **Good flexibility at low temperatures**

Whatever your coated, cast or slush-molded product, it will pay you to investigate Opalon 410 resin. For full information on this new plastisol for your product, write: MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2905, Springfield 2, Mass.

Opalon: Reg. U.S. Pat. Off.

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SPE JOURNAL

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Jesse H. Day

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Here's how to

reduce size & weight

(WITHOUT DECREASING OUTPUT)

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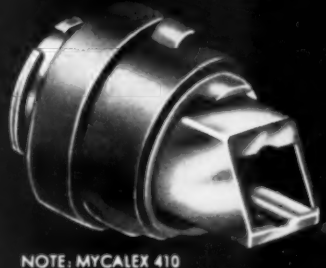
MYCALEX 410 glass-bonded mica withstands continuous operating temperatures of 650°F. This temperature endurance makes it possible to install MYCALEX in critical insulating areas—slot wedges and brush tubes—thereby increasing permissible temperature rise of motors and generators. Thus power ratings may be safely increased without change in size or weight. Conversely, a unit of specified size can be redesigned to smaller dimensions. Significant gains have been made in this direction, particularly in aircraft systems. Dimensional accuracy of these parts injection-molded of MYCALEX 410 glass-bonded mica, the unique ceramoplastic insulation, exceeds that of any ceramic or plastic material . . . their smooth surface speeds assembly, reduces costs. For complete information call or write J. H. DuBois, Vice President-Engineering, at Clifton, N. J. address below.



NOTE: MYCALEX 410 glass-bonded mica, described above, is an exclusive formulation of, and manufactured only by, the Mycalex Corporation of America. It meets all the requirements for Grade L-4B under Joint Army-Navy Specifications JAN-1-10.

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Industry Notes

Production Equipment for Economical Processing of Polyesters

Processors of polyesters, epoxies and other multi-component resins can now handle them on a production line basis with new automatic equipment designed and manufactured by Applied Engineering Associates, 1952 Flushing Avenue, Brooklyn 37, New York. The use of this equipment leads to substantial cost savings through maintenance of quality control and reduction in labor costs. Present and potential applications are in the fields of laminating; mat molding; matched die molding; plastic tooling; adhesives and sealers; potting, casting, embedment; protective, decorative and sealant coatings; and thermosetting extrusion.

The equipment automatically performs the functions of deaeration, proportioning of the resin and hardener components, mixing and meter dispensing. It will process polyesters, epoxies, allyl resins, furans, modified phenolics and polysulfide liquid polymers. Resins in a wide range of viscosity and pot life, including the cheaper hot melt types and filled compounds can be satisfactorily handled. The short or limited pot life of many of these resins is no obstacle to continuous processing since the equipment is designed to dispense mixes with a constantly extended and uniform pot life.

New Self-Contained Vacuum Forming Machine Is Ready to Operate as soon as it is plugged in

Model HV-30-60 of the PAMCO HYDRO-VACUMATIC has been introduced as the first completely self-contained machine for high-speed vacuum forming of thermoplastic films and sheets.

The machine is ready for operation as soon as it is plugged into an electrical connection, since it requires no supplementary equipment. Its built-in components include an air compressor and mold clamp frame assembly as well as a hydraulic pump which is unique in this kind of machine and which provides smoother and quieter press action than other methods now used.

Further information about the HYDRO-VACUMATIC is obtainable from Pamco Industries, Inc., Ludlam Ave., Bayville, N. Y.

Spiwak with Rogers

L. Spiwak is now Plastics Engineer with the Rogers Corporation, Goodyear, Connecticut. He was formerly with the Snyder Chemical Corp.

Joseph Fiedler Deceased

F. and E. Mold and Die Works, Inc., Dayton, Ohio, announce the death of its co-founder, Joseph Fiedler, March 29.

Across the Editor's Desk . . .

• A general index to all technical articles published in the world is put out by the Studieselskapet for Norsk Industri. Reason for imparting this information is that the index for 1951 has just arrived, is 170 pages long. Article titles are listed, with reference to the issue of the Teknisk Ukeblad Indeks which carried an abstract of the original article. It's too bad there is no edition in English, since this is a tremendously worthwhile publication.

• And on the subject of Norway, the SPE Journal receives the monthly magazine AJOUR SNI, about 30 pages in size, very well printed. We are looking for someone to abstract this journal for the SPE Journal. If you can handle Norwegian, drop us a line.

• The Second Basic Materials Conference is being held in Chicago May 17, 18, 19. Afternoon session May 18 will be a panel on How, When and Where to Use Non-metallic Materials. First speaker, on Plastics, is SPE member Jesse Day.

• Despite the fact that this is the fattest Journal yet, excepting roster issues, we had to defer several articles; which will now go to making the June issue a really big one.

The Durez Molder has long been one of our favorite publications, especially the paragraphs written by Old Bill. Now we see in the February issue a reprint of extracts from Jean Reinecke's article on Industrial Design which appeared in the January issue of the SPE Journal. We believe that this is the first time we've been reprinted in a company publication, and we find that we are pleased by it all. A bow to the Durez Molder.

• Couldn't help noticing that the same topic is covered on our cover page, on page 11, in the Section News for Newark, and in the Injection Molderscope. Please note; important topic.

A.S.T.M. Standards

Committee D-20 has written a Tentative Method of Test for Determining Chlorine Content of Vinyl Chloride Polymers and Co-polymers (D 1303) in which is outlined the procedure used throughout the industry as a means of characterizing chemically these resins.

The Plastics Committee also has revised several of the Tentative Definitions of Terms Relating to Plastics (D 883) as a result of specific requests to bring them into accord with current usage in the field of plastics technology.

Copies of all new ASTM specifications will be available at a later date from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa. at a nominal charge, usually 25 cents each, but slightly higher on standards over 16 pages.

DRYCOL to color ALL PLASTICS

DEPENDABLE as your

DRYCOL is a carefully formulated and intimately blended colorant of the most stable light-and heat-resistant pigments available; specifically developed by our expert color chemists for use in QUICK, EASY, ON-THE-SPOT coloring of all plastics compounds, in injection or extrusion molding. Contains well-known Gering lubricant, assuring freer mold release, fewer rejects. Available in units to color 50 or 100 lbs. plastic materials. Immediate shipment in all standard and metallic colors.

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New and BETTER impact phenolic!

DUREZ 16840

NITRILE RUBBER BEARING TYPE

for a market that's growing bigger

● Molders and their customers have recognized many profitable applications for nitrile rubber bearing phenolic molding compounds developed by Durez. Now, to provide better all-round properties in an impact material of this type, we offer Durez 16840 black thermosetting for this growing field of application. 16840

16840 ● The modulus of the new material is lower in practical application than materials of similar type and impact strength is nearly 20% greater. The cure is slightly faster and surface finish has a higher gloss and fewer flow lines.

● The low modulus of elasticity of 16840 allows it to be used in thin sections around inserts. It absorbs shock more readily than standard wood-flour or flock-filled materials and may be readily molded either by compression or the plunger method. 16840

Data is available. Write Durez Plastics & Chemicals, Inc., 1105 Walck Road, North Tonawanda, N. Y.

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MOLDING COMPOUNDS

INDUSTRIAL RESINS

PROTECTIVE COATING RESINS

PHENOLIC PLASTICS THAT FIT TODAY'S PRODUCTS
for the new era of competition

Book Reviews . . .

MATERIALS AND PROCESSES by James F. Young. Second edition, 1074 pages. Published 1954, by John Wiley & Sons, New York.

Why would a man in the plastics business be interested in this book, since there is only a single chapter on Plastics? It comes to your reviewer that here is a book which gives the plastics man a good chance to know about materials which are competitive with plastics, and what their properties and limitations are (ceramics, rubber, glass) and an equal opportunity to learn about materials and processes that the plastics engineer must not be ignorant of—certainly an understanding of welding, metal working, and machining are valuable.

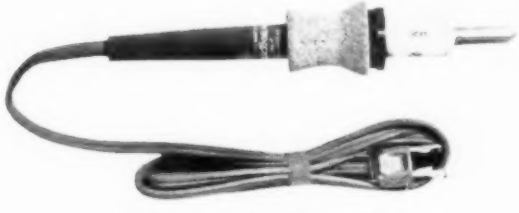
This is an easy to read, well-written book covering the main engineering materials and processes. Each chapter deals with one topic, and nowhere is the going heavy.

This book is one of a series written in the interest of the General Electric Engineering Educational Programs. The first half is devoted to the engineering properties of materials; seven chapters deal with metals and seven chapters deal with nonmetallic materials. The second half of the book covers processes; Casting; Powder Metallurgy; Heat Treating; Hot-Working; Cold-Working; Welding and Allied Processes; Machining; Cleaning, Plating and Organic Finishing of Metals; Gaging, Inspection, and Nondestructive Testing; and Statistical Methods Useful in Industrial Quality Control.

This is a good browsing and reference book for the plastics engineer or executive.

J.H.D.

made from a cāco MOLD



PLUNGER MOLDED HANDLE

By—Ungar Electric Tools, Inc., Venice, Calif.

cāco INCORPORATED

1193 W. SECOND STREET POMONA 6, CALIF.
LYCOMING 9-5206

Quotations promptly given

Molder: General American Transportation Corp., Chicago, Ill.

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	"High Impact," Lowest Water Absorption Rate
MC-301	"High Impact" Improved Heat Distortion
MC-305	"High Impact," Easy Flow
MC-309	"High Impact," Highest Heat Distortion Temperature
MC-401	"Medium Impact," Improved Heat Distortion Temperature
MC-405	"Medium Impact," Easy Flow
MC-409	"Medium Impact," Highest Heat Distortion Temperature

● Westinghouse Electric wanted another liner for refrigerator doors—one that would be easy to clean, odorless, shock-resistant, and yet low in cost.

The molder, General American, suggested use of a liner made from a special, high-impact plastic. Koppers Modified Polystyrene MC-305 met the requirements, and is now used in several Westinghouse refrigerator models.

Koppers Polystyrenes, both regular and modified, have helped many manufacturers improve their products, and/or cut production costs. These plastics flow easily during molding, thereby reducing the molding cycle and increasing production. Our technical staff will be glad to assist you in selecting the specific Koppers Polystyrene that best fits your needs. Call or write your nearest Koppers office.

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EVERY TYPE OF "MICA"

for use as fillers in

PLASTICS

Two associated companies offering every type of Mica . . . either the **Coarser** Dry-Ground **Mica** or the **Finer** Waterground and Micronized Mica . . . have representatives and warehouse stocks located for customer convenience in all principal cities of the United States and Canada.

Mica is excellent for use as Fillers in Plastics. It is a flaky mineral having ideal Thermal Insulation properties and High Dielectric Strength. It is transparent, tough, flexible and chemically inert.

U.S. Mica Co., Inc. with plants at Forest Park, Illinois . . . East Rutherford, N.J. . . . and Kings Mountain, N.C. has the coarser grades available from 5 to 100 mesh.

The English Mica Co. . . . of 79 Prospect Street, Stamford, Connecticut . . . has the finer grades available from 160 mesh to a theoretical 3,000 mesh.

Write The English Mica Co. . . . of 79 Prospect Street, Stamford, Connecticut for information on the Finer Ground Micas and U.S. Mica Co., Inc., Jordan & Van Dyke Streets, East Rutherford, N. J. on the coarser Ground Micas.

SECTION MEMBERSHIP COMPETITION

Goal: 5000 Members By October!

	MEMBERSHIP		NEW APPLICANTS			
	Oct. 1, 1953	Oct. to Jan.	Jan.	Feb.	Mar.	Apr. to Date
Baltimore-Washington	49	1	1	3	0	10
Buffalo	65	5	1	0	0	0
Central Ohio	33	1	0	0	1	6
Chicago	315	21	6	1	0	10
Cleveland-Akron	118	17	6	4	0	14
Connecticut	86	7	1	2	1	4
Detroit	173	13	4	5	1	7
Eastern New England	132	5	3	1	1	4
Golden Gate	32	5	3	1	1	4
Miami Valley	102	2	0	1	2	5
Milwaukee	1		8	0	11	19
Newark	321	31	6	0	10	16
New York	248	32	12	14	4	30
Northern Indiana	21	1	2	2	0	4
Northwest Pennsylvania	75	8	0	1	1	2
Ontario	43	23	31	0	0	31
Philadelphia	174	9	12	7	2	21
Pittsburgh	6	8	0	2	1	3
Quebec	25	16	8	2	1	11
Rhode Island & S. E. Mass.	68	4	3	0	0	3
Rochester	65	10	2	1	0	3
St. Louis	71	13	1	2	0	3
Southeastern Ohio	36	4	0	0	2	2
Southern California	96	15	3	2	1	6
Southern Section	3		9	24	6	39
South Texas	32	6	1	2	0	3
Toledo	59	0	1	0	0	1
Upper Midwest	54	5	3	0	2	5
Western New England	135	15	7	7	3	17
Non-Section	33	0	0	6	0	6
TOTALS	2704	267	135	90	75	300

New Sections!

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YOU GET JUST WHAT YOU PAY FOR IN MOLD RELEASES

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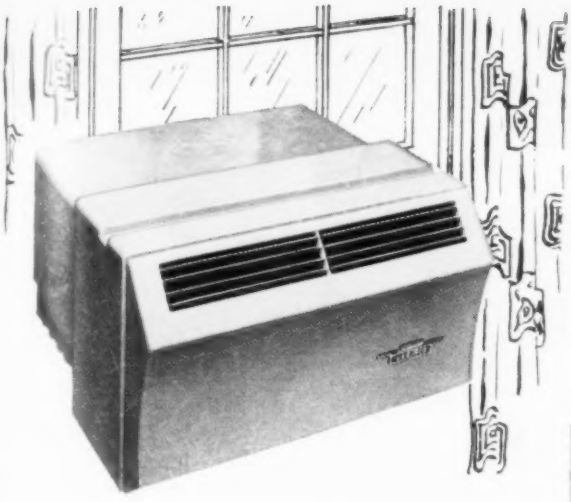
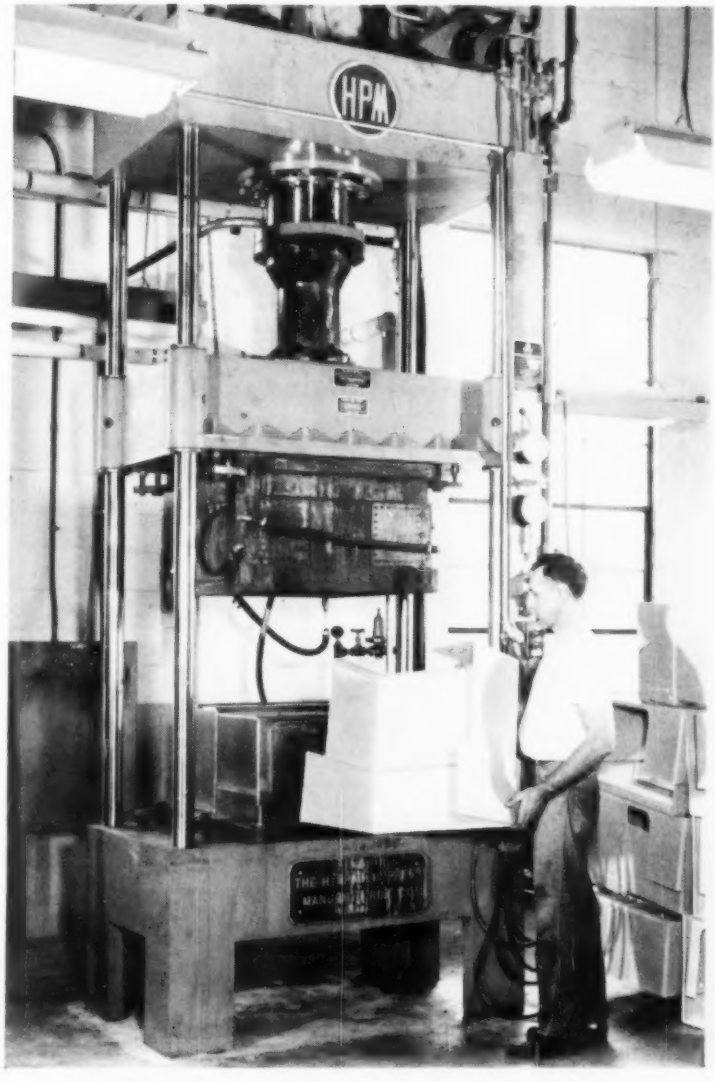


H-P-M STOCK PRESSES SOLVE TOUGH MOLDING JOB FOR STRUCTURLITE!

AIR CONDITIONING . . . A NEW FIELD FOR REINFORCED PLASTICS!

H-P-M was ready with a complete line of stock presses when the room air conditioning boom hit . . . and Structurlite Corporation took advantage of it. They secured contracts, ordered 100-ton H-P-M presses and are really in business.

H-P-M builds a complete line of stock presses, each with enough daylight and stroke for every job . . . from flat parts to washing machine tubs (see the tough part in the illustration). Each press is equipped with the accurate automatic controls so necessary in the molding of reinforced plastics. Talk to an H-P-M engineer, today, about stock presses for this booming industry!



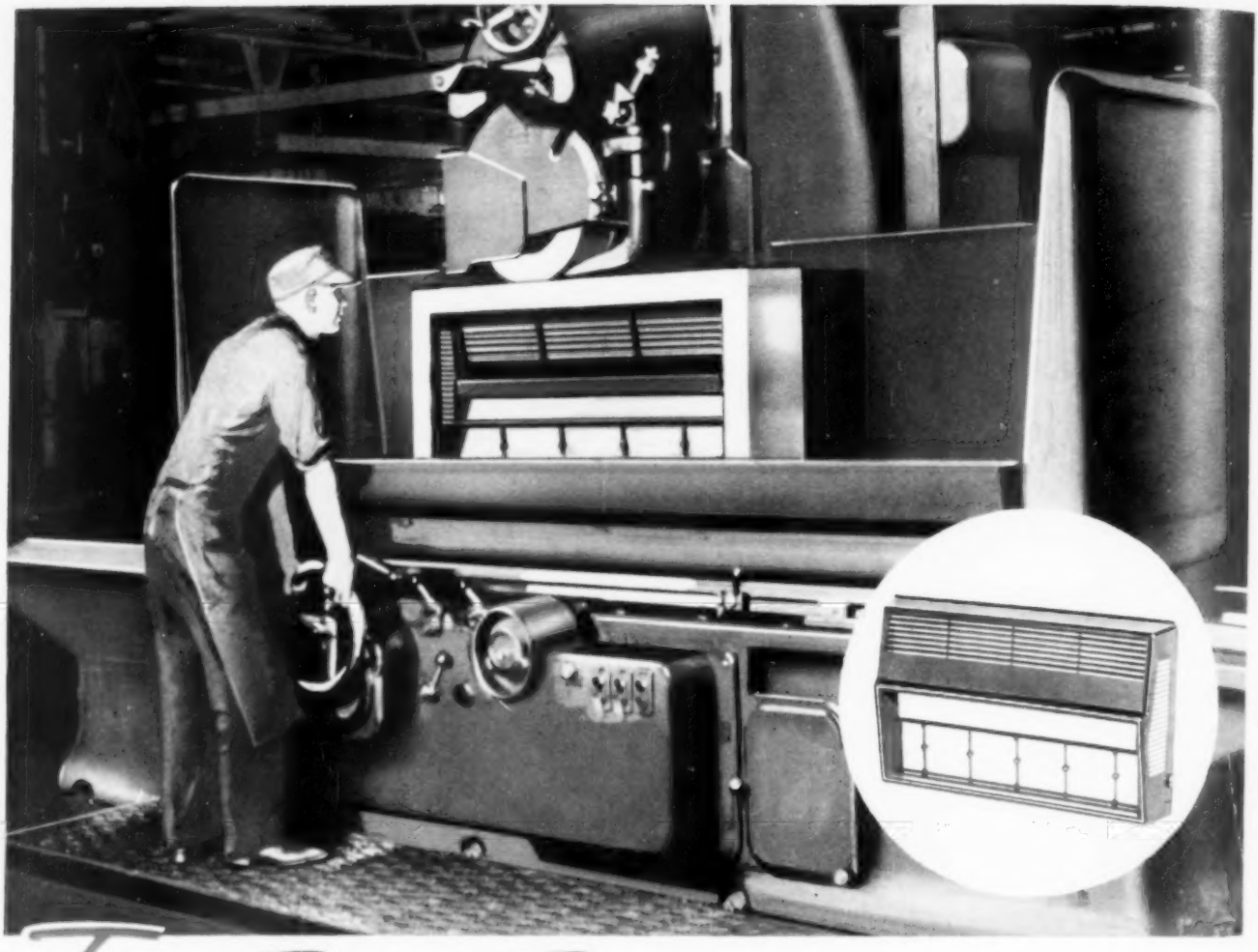
This 100-ton H-P-M is producing housings for the United States Air Conditioning Corporation room air conditioning units shown above. Cabinet measures 16¾" x 26½" x 25½", weighs 8 lbs. and is a polyester-fibre-glass material.

HPM

THE HYDRAULIC PRESS MFG. COMPANY

3015 MARION ROAD MT. GILEAD, OHIO

Presses for Every Pressure Processing Need!



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AT LOWER COST... A PERFECT MOLD

At Newark Die Company skilled craftsmen guide modern machines to fashion molds of superior quality . . . a vital step in making a better molded product at lower cost. Here a giant Mattison surface grinder readies a mold for the ornamental grille of an air conditioner. With unerring precision it squares the mold and smooths the parting surface to a flawless finish . . . one of the many steps in the making of a perfect mold. Into this and every stage of mold-making at the Newark Die Company goes a combination of engineering know-how, proud craftsmanship and unsurpassed facilities . . . a combination that has set mold-making standards for more than thirty years.

NEWARK DIE COMPANY

22 SCOTT STREET, NEWARK 2, N. J.

Phone: MArket 2-3305

NDCo TRADE MARK

YOUR NATIONAL OFFICE

PRESIDENT LABELLE SIGNS "STATEMENT OF PRINCIPLES"

History was made for the plastics industry March 8, 1954. The place: New York City. The occasion: the signing of the "Statement of Principles by the Plastics Industry."

Your National Council accepted the "Statement" on January 26th and National President John LaBelle joined with three other major associations in the official signing (see cover).

The highlights of President LaBelle's address at this ceremony follow.

"Now that there is no shortage of any chemicals, or plastics made therefrom, the plastics engineer can exercise his ingenuity without restrictions. As time goes by the world in which we live gets more and more complicated and higher demand is put on all materials of manufacture. Witness the fact that the jet age is demanding a higher and higher heat resistance and strength properties in all the functioning parts of the plane.

"Again, as we advance in atomic science, the demand is created for new and better materials. Here plastics has a golden opportunity to demonstrate that our chemists, physicists and engineers accept this challenge and in most cases meet it successfully.

"Our polymer scientists can create new substances not yet in existence, whereas our competitors in glass, metal, wood, paper and ceramics can only modify. There has been a recent spurt in all the fields competitive with ours and it is up to the plastics industry now to demonstrate that they can thrive on end uses with more stringent requirements.

"We must engineer top quality into all articles for which we are responsible and we must search unceasingly for new materials to better satisfy the consuming public.

John W. LaBelle

"The Society of Plastics Engineers pledges itself to make all its members aware of the big and important tasks that our industry faces. Our industry must not repeat the mistakes of the past, but rather assure its customers that it is prepared to give them the finest qualities possible in all plastic items."

President LaBelle added that he saw the "Statement of Principles" as a forwardlooking document which put the industry on record as being aware and watchful of possible hazards which could befall any enterprise as expansive and dynamic as the present day field of plastics.

Each member of the Society is urged to be guided by these principles and to accept them.

P. L. Underwood

Executive Secretary

automatic HIGH SPEED injection molding

Ernest P. Moslo
Moslo Machinery Co.

INTRODUCTION

We are living today in the age of nuclear energy, atomic and hydrogen bombs, and the age of automatic machinery. Our progressive automotive industry is making cylinder blocks on machinery that is almost completely automatic. Just a few years ago they used a series of twenty to thirty machines to turn out this job. Innumerable hands contacted this piece of iron. Today, it's a matter of a couple of automatic machines that will even shut themselves down should a tool wear and tolerances not be held. Were it possible for our forefathers to come back to this earth, and take a trip through some of our modern manufacturing plants, I am sure that they would shake their heads and say . . . "It can't be so".

The plastic industry in comparison to the automotive, steel and other industries is still in its infancy. However, due to the ingenuity of the engineers and the manufacturers in our industry it is fast coming of age. The first injection molding machine was imported into the United States from Germany by the Index Machinery Company of Cincinnati, Ohio. The man who was the pioneer of injection molding machines in this country was the importer, Mr. Joe Geers. This first machine was placed on exhibit in the plant of the Kurz-Kasch company in Dayton, Ohio. However, they didn't buy it. Apparently the first machine to be installed in the United States was this Isoma injection molding machine delivered to Erie Resistor Corporation in September 1935. This machine was semi-automatic, would mold from three to six shots per minute and had a capacity of one and a quarter ounces. The first American produced injection molding machine was built by the Hydraulic Press Manufacturing Company at about this time, with a capacity of two ounces.

Tremendous advancements have since been made. Today, injection machines are in operation that inject between three and four hundred ounces of material in one shot. However, in spite of the large machines, the smaller machines are of prime importance.

Like every industry, the plastics industry is interested in its future. Of major importance is this one question that the molder asks himself—can we compete? In answer to this question, the engineers in the machinery business have developed and built a line of fully automatic plastic injection molding machines.

The fully automatic injection molding machine, regardless of who builds it, must be well designed and well balanced. It must be simple in its construction and positive in its operation. In order to fully understand how and why a fully automatic plastic injection molding machine functions, one must understand that it is possible only after a complex co-ordination of three factors, electricity, hydraulics and mechanics. Each of these is equally important and I will attempt to explain briefly how each plays its part in the role of fully automatic plastic injection molding.

THE ELECTRICAL SYSTEM

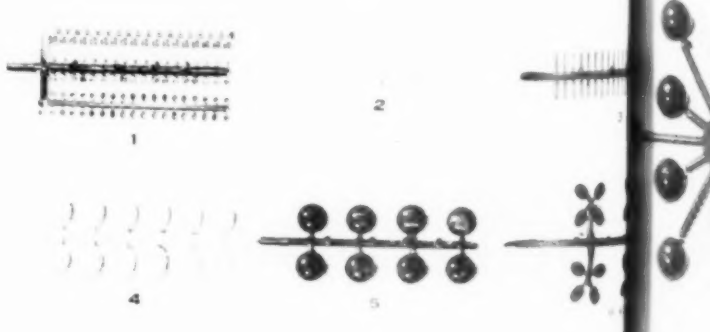
Let us start with the electrical system which is the nerve center of this machine.

On most high speed machines, provisions are made which make it possible to operate the machine either manually, semi-automatically or fully automatically. Since manual operation is simply push button or lever control of the machine, we won't spend much time discussing it. Semi-automatic operation, I am sure, you are all familiar with. Fully automatic operation is the interest of the day.

To ready an automatic machine for production, it must first properly install the mold. The pyrometers are set for proper temperature control of the heating cylinder to insure plasticized material for our mold. In automatic molding these pyrometers should be of the proportioning type, to accurately control the temperature of the material. Our timers are set for an estimated production cycle, which is generally a little longer than the final actual cycle required to produce the shot. Let me stress that good timing equipment should be used.

To give you a run through of the electrical equip-

Novelty items molded by automatic injection process, using uniform and hence interchangeable mold cavity plates.



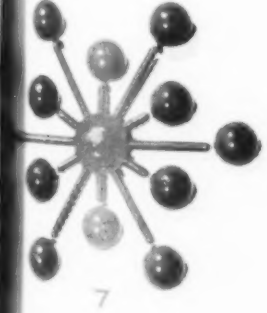
this piece of machinery, there are a group of switches for positioning the machine for its function, a group of limit switches that control the various phases of the operation, a number of relays, time delay relays, timers and so on.

To operate the machine automatically, the safety gate is closed and stays closed as long as the machine functions properly. By closing this gate, we have started the master center to function and the results are as follows:

The safety gate, closed, releases the limit switch which energizes the machine over-all cycle timer. The over-all timer contacts, immediately energizes the clamp open solenoid valve, closing the clamp. The clamp forward limit switch is tripped, energizing the injection timer which immediately energizes the forward hydraulic solenoid valve. The injection ram advances and is timed by the injection timer until the time of the desired injection cycle is complete. The injection timer times out, the injection ram returns and in the case of many machines, an injection counter timer is energized, the injection ram then advances and returns between the count limit switch and the injection limit switch to repack the cylinder with the proper amount of material required for the next shot. The number of these short strokes is controlled by the setting of the counter timer. After the count limit switch is opened for the last count, the counter times out and the injection ram stops on the forward count limit switch or in the advanced position, ready for its shortest stroke for the next injection. The over-all cycle timer times out, energizing the clamp open solenoid. The clamp opens, tripping a clamp return limit switch which de-energizes the over-all cycle timer and a repeat cycle pneumatic timer is energized which, after a short pause, closes the clamp again and starts another cycle. The machine continues to function until the gate is opened, the selector switch is turned off, or a jam occurs in the mold due to a part not ejecting properly.

We might say, at this time, that the electrical system of your machine has a great bearing on the efficiency, safety and continued operation of this piece of equipment. The electrical equipment must be of the highest

Twelve cavity moldings of fishing floats. This is an example of poor mold design. Better would be to place floats in two parallel rows.



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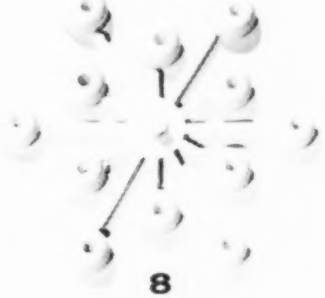

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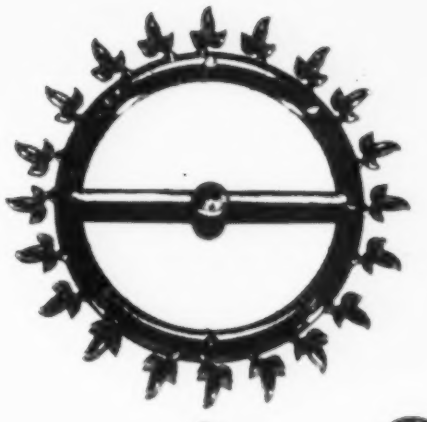
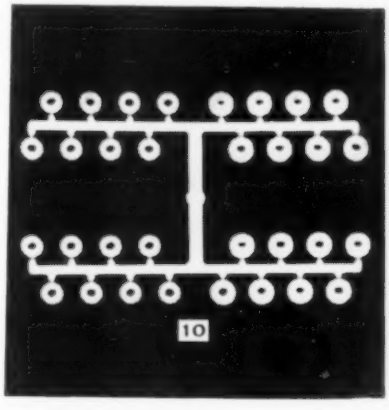
B



9

C

No sprue! Molded in a twenty-cavity ring-gated mold, the sprue bushing completely removed, are these plastic leaves.



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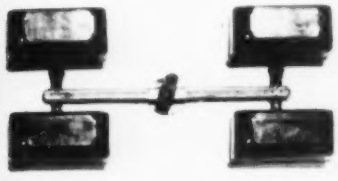

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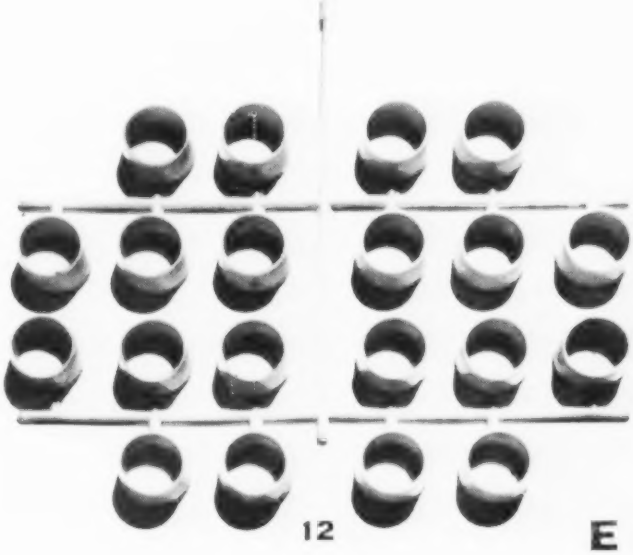
D

Nylon parts molded by high speed automatic injection molding.

Chair tips molded from polyethylene by automatic molding.

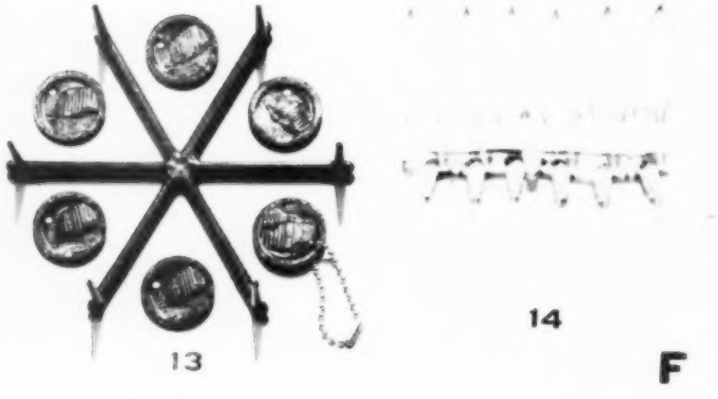


12

E

caliber obtainable and standard in the industry. Being an important function of your machine, the control panel should be neatly wired. Wiring should be color coded and properly marked. Over-load protection for all units and an electrical panel interlock should be provided for protection of the electrical components. Operator and machine safety are accomplished through these electrical interlocks.

Without an efficient hydraulic system on which a machine depends for speed and operating pressure, our electrical system would mean nothing. A good hydraulic system begins with the capacity of the oil reservoir which should be at least three times that of the rated capacity of the pump used in the machine. A baffle is usually placed through the center of this oil tank. The hot discharged oil should enter on one side of the baffle, the intake oil is taken from the other side. The capacity of the oil tank is dependent somewhat on the size of the heat exchanger used to cool the oil. Oil which returns



(left) Group of medallions from three plate mold, and (right) boats and sails in 12-cavity family mold, run by automatic molding.

from from a job well done, will return to the tank through the heat exchanger coils for cooling.

The hydraulic pump is the heart of this hydraulic system. It is this pump that takes the oil from the reservoir and speeds it on its way to do its job. The hydraulic pump must be provided with a proper over-load relief valve, either built into the pump or externally provided. Without an over-load relief valve, the pump would continue to build up pressure and stall the motor or ruin itself. The over-load relief valve is usually adjustable and set for the desired or rated operating pressure of this piece of equipment.

Most machines for automatic molding employ one double solenoid pilot operated four-way valve for the clamp cylinder, one double solenoid pilot operated four-way valve for the injection cylinder and one pilot operated two-way valve for the low pressure clamp system. Different valving systems, however, are used by the various manufacturers.

A must on automatic injection molding machines is an adjustable relief valve placed in the line leading to the pressure end of the injection cylinder. With this valve, pressure is controlled on the material being injected into the mold without affecting the oil pressure on the rest of the hydraulic system.

Hydraulic cylinders on this injection machine should be of first class mechanical and hydraulic design. Piston and rod packing should have an adjustable packing gland for take-up, should leaks occur. Adjustable cushi[on] at the end of the stroke are an asset to prevent bang[ing] in very high speed operation. A good hydraulic syst[em] sures high speed automatic molding.

Of equal importance in the construction of your automatic plastic injection molding machine is good and simple mechanical design.

Interchangeable parts are of utmost importance and a clamp lock of adequate tonnage is a must. Unless this machine is built to close mechanical tolerances, it will not function properly.

Your automatic machine must have an over-sized plasticizing chamber. There are two questions that are often asked of me. How much will the machine shoot at one time and how fast will the machine cycle? With this information, the molder starts to figure his job, completely forgetting about the amount of material the plasticizing chamber is able to produce. This can mean trouble. The molder must consider the plasticizing capacity of his machine, the total projected clamping area the machine will mold, and the speed of the machine. But of greater importance is the design of the mold and the cure cycle of the piece.

Automatic molding is not only a question of how fast a part can be run, but how successfully it can be run. Speed is important but a steady run of saleable parts is a must.

Your automatic machine must be equipped with a good compensating feed mechanism as it is important to feed the proper amount of material for each and every shot. Should the feed on your automatic machine be erratic, a pressure variation will result from shot to shot. Pressure, as you know, is created by the amount of material in front of the piston. If this varies, pressure varies, if pressure varies, sticking will often occur in the mold. With shots that have little build-up in front of the piston, the mold cavity will be packed too tightly. With this condition, parts are apt to stick. With a large build-up of plastic in front of the piston, short shots often occur. An even feed guarantees constant production.

There are many advantages to high speed automatic molding on a well designed machine. Mold cost is lower, initial equipment cost is lower, one operator can operate at least three machines, and capital investment is much lower, there is also considerable saving of floor space.

Molds with fewer cavities, operating at high speed, turn out greater production. Instead of the molder having the mold built for small parts with large number of cavities to be run in a large machine, it is often to the advantage to build a mold for high speed automatic molding of much smaller size with fewer cavities and to run the job automatically.

There aren't nearly as many variables, in fully automatic molding as go hand in hand with semi-automatic operation. The safety gate is kept closed. Under the circumstances, the plastic being injected into the mold is of an even temperature on each succeeding shot. With constant feed, pressure on material is uniform, quality is constant and the danger of flash is practically eliminated.

To facilitate removal of parts in your automatic mold, it is desirable to have a slight time delay when the mold clamp is fully open. An air blast valve operated on the opening of the mold is an asset. At times it is well to connect the air directly to the cavities of the mold itself to remove parts.

Most high speed automatic machines have a built-in safety device which consists of the two pressure systems that I mentioned earlier. If a part or even a

BASE HIT—NO RUNS

Stockings don't snag, shoes don't get scuffed on this swivel chair base molded in one piece from BAKELITE Phenolic Plastic. The surface is smooth and shiny—no burrs or rough edges. It has no applied finish because the color—gleaming black or rich walnut—is the intrinsic color of the plastic.

The lightweight plastic construction helps make the chair easy to handle. And the mechanical strength is so high that the manufacturer's guarantee is able to state that a 1000 lb. weight dropped one inch onto the plastic base had no harmful effect.

Large size meets low cost in this molding. It's made from a BAKELITE General-Purpose Phenolic. Other BAKELITE Phenolic Molding Materials include heat-resistant phenolics, electrical insulating grades, and special types for unusual operating requirements.

These BAKELITE materials cover a great range of service properties. They are backed by manufacturing and development resources of BAKELITE Company. To learn how they can bring sales and production advantages to your operations, write Dept. XA-43.

Swivel chairs with bases of BAKELITE Phenolic Plastic are made by **Dependable Mfg. Co.**, Omaha, Neb.

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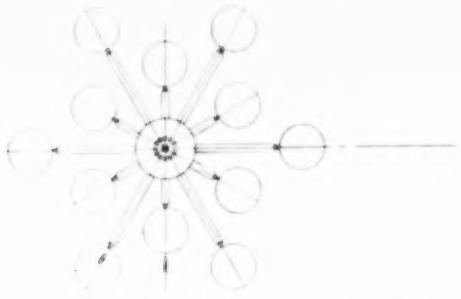
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company
Division of Union Carbide Canada Limited
Belleville, Ontario



Sketch 1. Complete shot of fishing float of poor design. Shot of 15.1 grams gives 12 floats.

flash a few thousandths of an inch thick sticks in the mold, the machine ceases to function. Even when using soft metal molds or cast beryllium molds—no damage is done to the mold if the machine is equipped with this safety device and properly adjusted.

The mold clamp is closed under very low pressure until the faces of the mold themselves meet. At this point a micro-switch is contacted, high pressure oil is directed to the cylinder and the mold is clamped. However, if a part or flash is left in the mold, the micro-switch is not tripped and as a result the clamp does not toggle out. Normally, an additional timer is wired in the circuit. This timer is set high enough so that during normal automatic cycling, it never times out. However, if a part is stuck in the mold, the timer does time out, this stops the machine from cycling, and sets up a circuit to a red indicating light which flashes, drawing the operator's

Sketch 2. Fishing float mold of good design. Shot of 15.5 grams gives 16 floats.

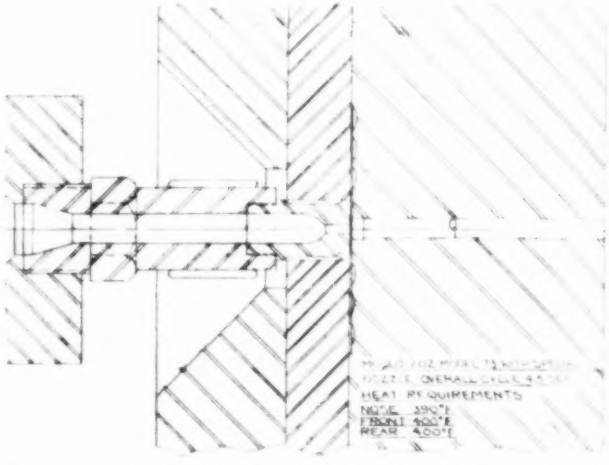
attention to the fact that something is stuck in the mold.

Mold design for automatic operation is very important. A customer, the Henry Lewis Company of Attleboro, Massachusetts, using a battery of 2-½ ounce Moslo High Speed Universal Injection Molding Machines, has worked out a very unique mold design. Being proprietary molders, principally of jewelry and novelty items, it was possible for them to arrange mold cavity plates of a uniform size with identical runner placement, knockout pins being in the same location on all mold plates. Their mold shoes remain in the machine at all times. To change molds, clamp strips are removed, the mold cavity plates are lifted out, new cavity plates are inserted into the mold frames and they are ready for operation in a matter of minutes. This same molder drills his cavity plates for water, allowing the water to run out of the bottom of the mold using this water to wash the finished parts down the machine discharge chute into a water cooling pan. (Refer to photograph "A", shots 1, 2, 3, 4, 5 & 6).

An excellent example of automatic molding is this twelve cavity fishing float, the shot weighing 15.1 grams. However, it is also an example of bad mold design. (See sketch No. 1 & refer to photograph "B", Shots 7 & 8). The parts being placed radially, require individual runners for each individual part. Were these parts placed in two parallel rows in the mold, the shots for sixteen cavities would weigh 15.5 grams or .4 grams additional. The molder could mold sixteen cavities instead of [illegible]. (See Sketch No. 2). This job is being run on a [illegible] model 73 fully automatic two ounce machine at the rate of four hundred shots per hour by the B.O.K. Company of Dayton, Ohio.

Another example of good automatic molding is a family mold of twelve cavities, six of boats and six of sails. (refer to photograph "F", shot No. 14). The shot weighs approximately 19½ grams and is being run fully-automatically on long production runs on an eight second cycle or 450 shots per hour on a three ounce Fellows machine by Thomas Manufacturing Company. Because of the fast cycle, it has been found that the best results were obtained when the molded parts were dropped directly from the mold into a water tank.

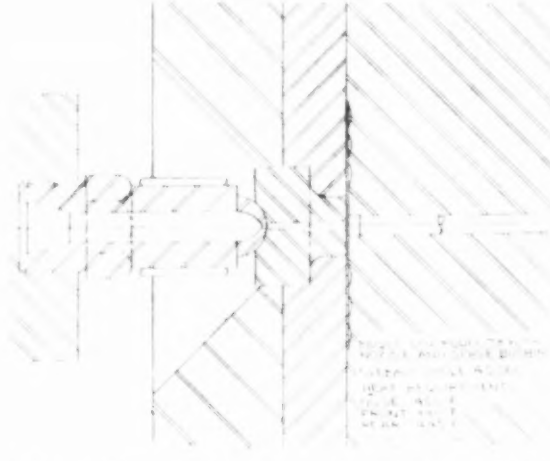
Another job on a three ounce Fellows at the Ford



Sketch 3. Nozzle extension of one inch eliminates the sprue completely.

Rotunda in Detroit, is a group of medallions in a mold of three-plate construction. (Refer to Photograph "E", Shot No. 13). This mold will not run as fast as a mold with ordinary gating but still the job is run completely and fully automatically. There is one advantage to three plate mold construction in that the parts are automatically degated and are ready to be boxed for shipment. The disadvantage of three plate mold construction in automatic molding is getting not only the parts but also the runners out of the mold and cleared for subsequent operations.

(please turn to page 50)



Sketch 4. Conventional nozzle before modification as in sketch 3 above.

Stress Cracking in Polyethylene Welds

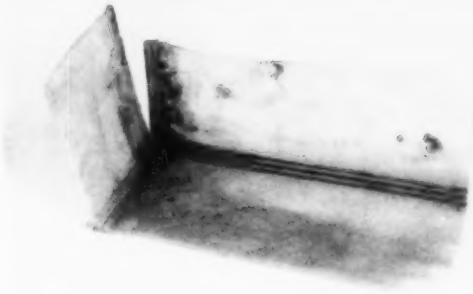


Figure 1. Photograph of corner weld failure.

by F. J. Bockhoff and
J. A. Neumann

*American Agile Corporation
Maple Heights, Ohio*

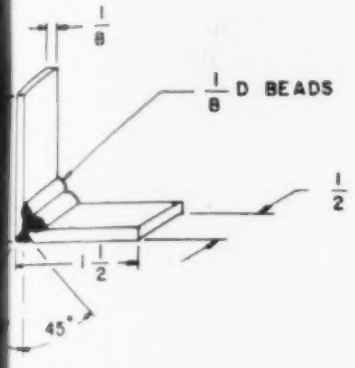


FIGURE 2. WELDED STRESS CORROSION SPECIMEN

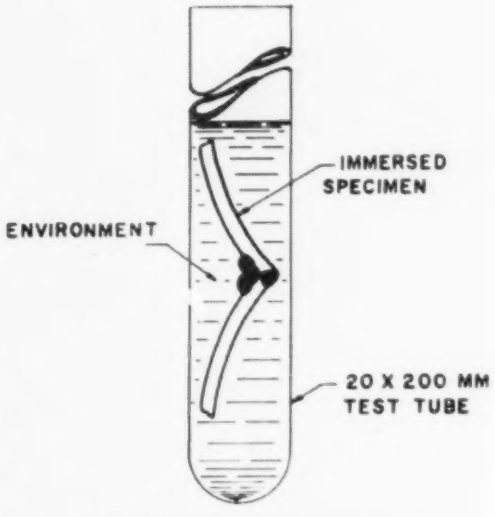


FIGURE 3. EXPERIMENTAL ASSEMBLY

INTRODUCTION

Environmental corrosion, which has long been recognized as a serious problem in polyethylene fabrication, involves a mechanical failure of the material in the presence of reagents which are not ordinarily considered chemically harmful to polyethylene. Environmental corrosion may assume various forms, such as stress cracking, stress corrosion, embrittlement, and crazing.

Experience has shown that two factors are necessary in environmental corrosion: (a) a polyaxial stress at the point of attack, and (b) an active chemical environment.

Crazing of various polymers has been attributed to stored mechanical stresses (1) which are acquired in the molding or fabricating operation. These stresses are assumed to release themselves in the presence of the proper environment, with the result that actual cracks (2) are produced on the surface of the polymer. These minute cracks invariably have been observed to occur perpendicular to the direction of major stress (2,3). Tests (3) indicate that crazing will not occur if the material is fully oriented in the direction of tensile stress, a criterion which inherently assumes uniaxial stretching.

Environmental effects in polyethylene were first observed by Richards (4) who noted that low molecular weight polyethylenes (Williams plasticity — 20-30) were subject to intense embrittlement in the presence of certain polar liquids such as acetone, lower alcohols, acetic acid, and nitrobenzene although the actual absorption of these liquids was quite small. This embrittlement, however, does not occur in polymers of sufficiently high molecular weight, i.e. above 27,000 (5).

The actual stresses required to promote environmental cracking in the presence of active reagents are usually of a magnitude which the polyethylene would ordinarily resist indifinitely. Experimental work has shown (6) that stresses below 200 psi may not be sufficient to cause environmental cracking, although larger stresses are definitely dangerous. When, however, the polyethylene is stressed under non-relaxing conditions in the absence of active environments, tensile stresses of 1000 psi have been tolerated without material failure for 16,000 hours even though imperfections were present in the specimen surface.

Under direct tensile stress, surface imperfections tend to distribute the forces in various directions, producing polyaxial stresses. It is at these points that stress cracking usually begins. It has been found (7) that if injection molded tensile specimens, with no surface flaws or scratches, are subjected to tensile stresses in the presence of an active environment, no embrittlement occurs, even in the case of low molecular weight resins. When, however, 1/16" diameter holes are drilled in the centers of the specimens, they function as stress distributors, imparting polyaxiality to the stress, and environmental cracking readily occurs.

Previous work (5) indicates that additions of butyl rubber and the 40,000 and 80,000 molecular weight grades of polyisobutylene impart essentially 100% crack resis-

tance in all proportions evaluated, 5% being the minimum tested. A serious disadvantage, however, in the polyethylene — polyisobutylene blend is the markedly lower resistance to oxidizing agents, as compared to virgin polyethylene. In addition, polyisobutylene additions tend to lower the mechanical properties values, such as stiffness, tear resistance and hardness.

A list of the general types of reagents which have been found to promote stress cracking is given in Table I.

ENVIRONMENTAL CRACKING OF WELDED STRUCTURES

One of the most common types of weld failures occurs in corner welds of $\frac{1}{8}$" polyethylene tank liners which are exposed to environmental cracking solutions. In a few striking cases, lined installations have failed within two days. Most liners, however, which are exposed to unfavorable conditions may last several months or several years, depending upon the concentration of active reagent, operating temperature and its fluctuation, and initial dimensions of the lining. In any case, the economic aspects of the problem are disturbing, since not only the liner must be replaced, but frequently the contents of the tank, which usually become contaminated upon liner failure.

This type of failure assumes the form of weld embrittlement, and the lining generally fractures immediately adjacent to a stressed corner weld. A photograph of this type of failure is shown in Figure 1. In some instances the entire corner weld may separate. Failure seldom occurs at butt welds on the sides of the tank liners, since the stresses produced can be absorbed by the entire sheet at these sections.

Corner welds, however, represent a high concentration of stress due to the differential expansion of polyethylene and steel. Polyethylene possesses a linear thermal expansion coefficient of 16-18 x 10^{-5} deg $^{-1}$C^{-1} as compared to 1.2 x 10^{-5} deg $^{-1}$C^{-1} for steel. For this reason, liners are generally fabricated to such dimensions that a snug fit is provided at the desired operating temperature. However, as is often the case, the customer frequently subjects the tank to considerably higher temperatures than the liner is designed to accommodate, with resultant high shear forces being concentrated at the corners. If the tank is empty, the stress generally distributes itself in the form of bellying at the sides. When, however, the tank is full of liquid, the hydrostatic pressure prevents this and directs the stresses into the corners. The magnitude of the stress is, of course, proportional to the size of the tank. Environmental failure is seldom encountered in tanks having sides shorter than three feet.

A similar situation is encountered when the tank is operated at a temperature much below the design temperature. In this case, the support of the steel tank is lost and the welds must bear the entire hydrostatic pressure, which subjects them to tensile loading.

When lined tanks are used at the predetermined design temperature, environmental failure may not occur over extended periods of operation, simply because the stresses are not sufficient to cause cracking. Localized thermal stresses are frequently encountered in plating tank liners when heating units are placed in the corners or near the lining. This practice is definitely undesirable, but, unfortunately difficult to eliminate. In this type of installation, failure generally occurs at the corner weld nearest the immersion heater.

An examination of the use history of several tank liner failures indicates that the materials contained in the tanks were not chemically corrosive to polyethylene. However, in every case, a surface active material could be attributed to each solution, e.g., plating brighteners, wetting agents in etching solutions, sulfonated oils from pickling baths which followed degreaser units, etc. These surface active agents, by nature of their molecular structures, are excellent cracking agents. The concentration of surface active agent need not be large, since even very small concentrations (e.g. less than 0.5%) would, by their very nature, tend to accumulate in higher concentrations at the surface of the polyethylene, thereby creating a much higher cracking potential than would be anticipated from the low concentration in the bulk of the solution. This is an important consideration which is often overlooked in stress corrosion problems.

TABLE I. TYPICAL ENVIRONMENTAL CRACKING AGENTS

Aliphatic and aromatic hydrocarbons
Alkali hydroxides
Alkanolamines
Animal, vegetable, and mineral oils
Concentrated sulfuric acid
Detergents, wetting agents, soaps
Ester-type plasticizers
Lubricants and mold release agents
Organic acids, aldehydes, ketones, and alcohols
Plating bath additives
Polyglycol ethers
Silicone fluids
Sulfonated fluids

Self-supporting welded structures of polyethylene are very seldom subject to environmental cracking, even in the presence of the worst environmental reagents. The primary reason for this is the absence of thermal stresses due to differential expansion, since the unit expands as a whole. In a few isolated cases, however, prolonged hydrostatic pressures in large structures have been sufficient to create the necessary stress for weld failure, although this is uncommon and the failure may have actually been due to a faulty weld.

EVALUATION OF CRACKING SUSCEPTIBILITY IN POLYETHYLENE WELDS

In order to intelligently pre-evaluate welded polyethylene installations for cracking susceptibility, a test must be proposed wherein a weld may be subjected to stresses similar to those in field service in the presence of environmental cracking reagents. A relatively simple test of this type, **Agile Test Method, 17-W**, has been found to yield reliable information under simple testing conditions. This method is similar to that proposed by DeCoste, Malm and Wallder (5) for sheet stock. The particular advantage of testing actual welded specimens rather than ordinary sheet stock is that the effect of many weld variables upon stress cracking resistance can be evaluated. A few of these variables are (a) operator technique, (b) linear welding speed, (c) welding temperature, (d) variable compositions for either spline or sheet, or for both, (e) surface preparation, and (f) weld dressing. Welded specimens are prepared to the dimensions shown in Figure 2. Four beads of $\frac{1}{8}$" polyethylene spline are applied as illustrated in Figure 2, using an electrically heated hot nitrogen welding gun operated at 650°F under a pressure of 4 psig and a flow rate of 0.5 cfm. The linear welding speed is maintained at 0.5 ft./min. Several specimens can be simply prepared by welding two $1\frac{1}{2}$" x $\frac{1}{8}$" strips of polyethylene together at 90°. The $\frac{1}{2}$" welded sections are cut from the center of the large weld on a

...ath saw. These specimens are then placed in a 25 ... 200 mm test tube containing the solution to be ... The specimen and solution under testing conditions ... shown diagramatically in Figure 3. A photograph of ... specimen assembly is given in Figure 4. The maximum ... occurs at the junction of the weld fillet and the ... and can be calculated to be approximately 250-300 ... the dimensions given in Figure 2.

... specimens are run at 25°C for each solution ... and the time to failure is recorded. Failure is ... recorded as having occurred in one of two possible ways: through the sheet itself, or through the weld with no sheet failure. The differentiation is important when the spline composition is different from that of the weld.

No failure is reported if the specimen does not fracture within 60 days.

The results of some typical tests of this type are given in Table II. Three types of welds were investigated in several solutions. The polyethylene was, in all cases, AGILENE (8). In addition to testing a normal weld, the effect of solvent cleaning and sanding the sheet before welding was investigated. In the presence of acetone, all of the welds failed rather rapidly, as also in the case of IGEPAL CA-633 (9) and AEROSOL OT (10). In concentrated H_2SO_4, however, the samples lasted several weeks to failure, and in some cases no failure was observed after 60 days. Sanding and solvent cleaning appear to lengthen the resistance time somewhat in the case of all but concentrated sulfuric acid, but the results cannot be accepted as conclusive.

Other evaluation tests have indicated no failure in the presence of water, salts of inorganic acids and bases in aqueous solution, concentrated hydrochloric acid, plain Watts nickel plating bath, or acid copper plating bath. It should be noted that the plating baths mentioned contained no brighteners or additives, and that addition of such agents will generally cause environmental cracking.

CONCLUSIONS

Even though virgin polyethylene possesses excellent chemical corrosion resistance, its use as a tank liner or supported lining should not be recommended in the presence of certain types of solutions which are noted for their ability to promote stress cracking.

The stress corrosion problem in polyethylene can be greatly alleviated, and in many cases remedied completely, by either increasing the molecular weight or by adding other materials to produce a modified blend. Polyisobutylene and certain petroleum resins have proved helpful along these lines. However, as previously mentioned, additives such as polyisobutylene may seriously affect the chemical resistance of the blend.

Evidence taken from testing programs now in effect indicates that polyethylene can be very effectively improved in its stress cracking resistance properties without any appreciable decrease in its chemical corrosion resistance, through the proper blending of several new types of resins. However, when unmodified polyethylene is used in supported applications, much discretion should be exercised. Its application should be avoided in all cases in which it will be in contact with known environmental cracking agents. If there is any doubt regarding its suitability, a simple test according to **Agile Test Method 17-W** can be conducted and the liquid can be evaluated before the installation is made.

It is highly recommended that the fabricator test the actual liquid to be used in the permanent installation, being careful to see that all additives are included, since, in many cases, customers do not know the exact compositions of their solutions. As previously outlined, even small percentages of foreign material may be dangerous.

In addition, much of the undesired stress in supported structures can be eliminated if the fabricator emphasizes the importance of operation of the equipment at the proper design temperature.

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Fig. 4 Test assembly

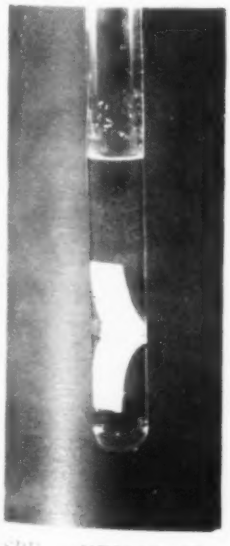


TABLE II. SUSCEPTIBILITY OF POLYETHYLENE WELDS TO STRESS CRACKING (AGILE TEST METHOD 17-W)

ENVIRONMENT	WELD TYPE*	% FAILURE	AVERAGE TIME TO FAILURE	% OF SHEET FAILURE
Acetone	1	100	14 min.	100
	2	100	23 min.	100
	3	100	40 min.	100
IGEPAL CA-633	1	100	148 min.	100
	2	100	215 min.	80
	3	100	160 min.	100
AEROSOL OT 5% AQUEOUS SOL'N	1	100	73 min.	100
	2	100	80 min.	80
	3	100	65 min.	80
Sulfuric Acid, Concentrated	1	40	24 days	100
	2	100	30 days	100
	3	60	22 days	100

*Key to Weld Types:	TYPE	SHEET & SPLINE	WELDING PROCEDURE
	1	AGILENE	Normal
	2	AGILENE	Solvent Clean
	3	AGILENE	Sand Surfaces

Accessory Equipment for Quality Molding

by W. E. Rahm
Boonton Molding Co.

A REMARKABLE MAN was the father of the plastics industry as we know it, and who anticipated the principles of injection molding in 1872 with his patent on the hydraulic extruder, John Wesley Hyatt was born at Starkey, New York on Nov. 28, 1837. He had a common school education plus one year at Eddytown Seminary where he excelled at mathematics. He went to Illinois at sixteen years of age to become a printer, which trade he followed for ten years. While at Albany, as a journeyman printer, he, working in his spare time, discovered and patented celluloid in 1870 as a substitute for ivory for pool and billiard balls. He moved to Newark, New Jersey in 1872-1873 and located on Mechanic Street in a two-story building near the center of town.

He engaged the services of Charles Burroughs, Sr. to build the machinery for manufacturing celluloid. Hyatt occupied one floor and Burroughs the other. After a disastrous fire, the city officials would not allow the manufacture of celluloid in the old location and the Celluloid company moved to the outskirts of Newark, which then was farm and meadow land.

The Charles Burroughs Co. was located at 141 Commerce St., Newark, N. J., where Mr. Hyatt maintained his office and where I had the good fortune to serve him as a part-time draftsman from 1907-1909.

Most people know Mr. Hyatt as the inventor of celluloid but do not know of his many other patents, including the Hyatt Roller Bearing, now manufactured by a Division of General Motors Corp. and patented in 1891.

Of the 238 patents held jointly or individually by Hyatt, these two are his outstanding inventions.

In addition to inventing the equipment used to manufacture celluloid such as the cake press, polishing press, dehydrating press, extruder and sheeting machine, I shall mention a few others such as:

A knife sharpener	186
Ball turning lathe	187
Machinery for manufacturing school slates	187
Bonsilate—a plastic consisting of bone and silica	187
Lock stitch sewing machine with 50 needles for stitching heavy fabric machine belting	190
Machine for straightening and cold finishing steel shafting	190

In 1881-1882 Hyatt took up the problem of water purification and filtration and formed the Hyatt Pure Water Co. Many paper and woolen mills as well as cities adopted his filters and he introduced them in Europe in 1887.

In 1891-1901 he designed, built and patented a sugar cane crusher which when tested initially ran for about five minutes before breaking down. From this run the percentage of juice extraction was so high that the resultant refuse or bagasse was dry enough to burn.

Based on this test he worked for 20 years trying to perfect the machine and up to the time of his death he would not admit failure.

He received the Perkins Medal Award in 1914.

Strange to relate, with all of his inventive genius and versatility not one of his patents is related to the printing industry for which he was trained.

Listed in the order of their importance are the items necessary for quality control.

Items 1 to 5, (1) Drying, (2) Mold Circulators for temperature controls, (3) Instrumentation, (4) Granulators, and (5) Screening reground materials. These, I consider necessary items.

Items 6 to 10 (6) Hopper loaders, (7) Weigh feeding, (8) Degating devices, (9) Annealing bath for nylon and cleaning machine parts, (10) X-Ray machine. These, I consider optional items predicated on the type and variety of items being molded.

(1) DRYING

Control of the moisture content of molding materials is of primary importance and this involves drying of the molding powder.

All materials manufacturers advocate drying the molding powder to obtain the best results.

While slight amounts of moisture above those recommended by the manufacturer may be permissible in some plastic molding powders and act as a plasticizer, the moisture does not improve the physical properties of the end product.

Moisture in acrylics, polystyrene and nylon causes splay marks, silver streaks, bubbles and may cause adhesions.

Each material should be dried in a separate oven since vapors given off by one material can and will contaminate dissimilar materials.

This is especially true of acetates with a high plasticizer content.

Therefore, the need for drying equipment will be

temperature control and the ability to obtain uniform results by proper loading of the pans. Material in the pans should be spread evenly and from 1 inch to 1½ inch deep for best results.

Drying eliminates the important variable in molding. Dryers are available in several types:

1. Hot air circulating ovens
2. Infra-red ovens. Not to be used for nylon as oxidation causes discoloration
3. Steam ovens
4. Hopper driers mounted directly on the injection machine

(2) MOLD TEMPERATURE CONTROL

The temperature of the mold is just as important as the temperatures of the injection cylinder for the following reasons:

1st—Proper mold temperature reduces strains in the molded parts

2nd—Makes it possible to mold thin sections over a larger projected area than would otherwise be possible

3rd—Molded parts have higher distortion and service temperature

4th—Control of dimensional accuracy

5th—Reduction in scrap loss when starting a new job

Mold temperature controllers are of two types:

1st—Recirculating type in which the fluid is returned to a tank and reused

2nd—Non-recirculating type in which the fluid is run to waste

Circulators should be of the dual type or so constructed that the temperature of one-half of the mold can be controlled independent of the opposite half.

(3) INSTRUMENTATION

1st—Accurate temperature control of the injection cylinder by proportioning pyrometers which will prevent overriding or underriding of the preset temperature.

2nd—Dependent on the number of heat zones a third or fourth pyrometer is necessary to control the temperature of the long nozzle required to mold nylon. However, a press equipped with a heated nozzle to mold nylon can be used for any molding material and in some instances may prove to be a decided advantage over an unheated nozzle.

3rd—An accurate surface hand pyrometer should be available to check the temperatures of the cylinder walls against the control pyrometers, to detect any wide variations in temperature and to locate dead heater bands.

All pyrometers should be inspected periodically and repaired or adjusted and at the same time the thermocouples should be inspected, cleaned and repaired if necessary. Dirty or corroded thermocouples are frequently a source of incorrect temperature indication by the pyrometer.

Thermometers cannot always be located in a mold to record the exact surface temperature and a surface pyrometer is invaluable for this purpose.

(4) GRANULATORS & CHUNK CUTTERS

Virgin material as delivered to the molder is of fairly uniform particle size which should be duplicated as nearly as possible when regrinding scrap sprues and runners to insure satisfactory molding conditions.

Nylon pieces ¾" or 1" thick can be successfully ground in a chunk cutter.

Reground material which is fed back periodically from a granulator located at the injection machine will not require drying, but reground which has been placed in storage should be dried.

(5) SCREENING REGROUND MATERIAL

Screening of material may not be necessary for molding certain types of pieces but for quality control of industrial items it is necessary to duplicate as nearly as possible the fairly uniform particle size of the virgin material and eliminate fines.

Fines have a proportionately greater surface area to volume than do the larger particles, hence, they pick up or absorb a proportionately larger amount of moisture.

For example, a 1 10" cube has a surface to volume ratio of 1 to 60 whereas a 1 100" cube has a ratio of 1 to 600 or 10 times the proportionate surface area of the larger cube.

Fines, because of their smaller size heat more rapidly in the injection cylinder resulting in non-uniform plastifying.

Vibrating screens are available for screening and can be furnished in 10 mesh or finer.

Fines can be dried and remolded.

I can see no good reason why granulators cannot be equipped with the usual screen and with another vibrating screen below to remove the fines and eliminate the extra screening operation.

THE OPTIONAL ITEMS

(6) WEIGH FEEDING

This is not a new idea. We used it in 1940 on a job where we had a large projected area and insufficient clamping capacity. We tried to interest the well-known companies who manufacture scales into developing weigh feeding, but without success.

Lately, several companies have developed weigh feeders.

The term "starved weigh feeding" is a misnomer because "starved" means skinny, emaciated and underweight and if you use this term when talking to a customer, he might get the idea you are short-changing him.

A better designation would be exact or precise weight feeding.

(7) HOPPER LOADERS

Hopper loaders are a convenience and reduce handling costs.

(8) DEGATING

The size and type of molded piece and the number of pieces required will determine whether hand trimming or mechanical multiple die degating is required.

(9) ANNEALING BATH FOR NYLON

The salt bath is used to anneal nylon pieces, and to clean or burn out the nylon in nozzles and injection cylinders or other metal parts.

Pieces are annealed at 350° F for the following periods of time:

Pieces up to ⅛" thick—10 minutes
Pieces from ⅛" to ½"—20 minutes

Cool the parts slowly in a cardboard container using cardboard layers.

The color of the nylon is influenced by the time in the annealing bath so it is desirable to keep this time as short as possible consistent with complete annealing.

Metal parts require 700° F to burn off the nylon.

Nozzles should not be quenched in water but allowed to air cool. Any salt remaining on the surface can be washed off with warm water.

(10) X-RAY MACHINE

The X-ray machine is used to examine the interior of non-transparent molded pieces for internal bubbles.

However, this method is not too reliable especially for thin pieces having very small voids.

high impact polystyrene sheet

F. J. McRae and W. D. Harris
The Dow Chemical Co.

F. J. MacRae

W. D. Harris

Since its introduction in 1948, high-impact polystyrene has experienced a steady growth as a thermoplastic raw material. It was quickly adopted by the injection molder for refrigeration parts and later for housewares and toys.

The extruders too found use for high-impact polystyrene but their requirements were limited until about two years ago when the first extruded high-impact polystyrene sheet was introduced. Since that time there has been a series of new developments such as:

a. The production of heavy gauge flat sheet by continuous extrusion.
b. The use of vacuum forming for mass production of thermoplastic parts.
c. The development of the continuous extrusion vacuum forming process.

As most of you know, fabrication of heavy gauge sheet by low pressure forming is not new, but aside from aircraft canopies very few plastic parts were fabricated in this manner. This was due to several factors, including both high material and fabrication costs. One might expect that a new material having a good balance of properties and a low cost, such as found in high-impact polystyrene, might prove to be a stimulus to vacuum forming. Experience has shown this to be true, and also that high impact polystyrene sheet possesses certain other characteristics that make it unique among the available sheet materials for vacuum forming.

When high-impact polystyrene sheet is formed over a mold, it does not spring away or "snap-back" when the forming pressure is removed. This permits closer tolerances on finished parts.

At the forming temperature of 270° to 325°F, this sheet flows easily and offers little resistance to forming. This means faster draws can be made and cycles shortened.

Because this sheet forms so easily, sharp intricate detail can be imparted to it from the mold face.

The scrap, if kept clean and free of contamination, may be reground and used for either extrusion or injection molding.

The sheet's low specific gravity coupled with its hi

PROPERTIES OF HI-IMPACT POLYSTYRENE SHEET

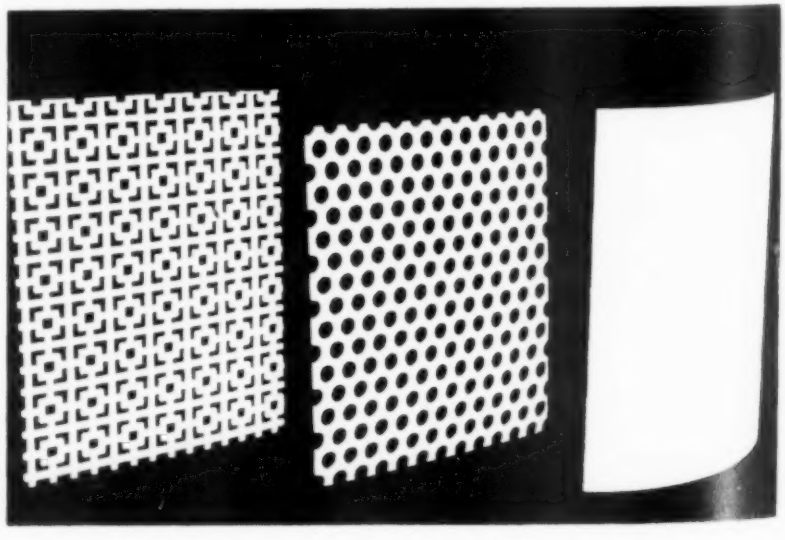
Gage 0.55 lb.

TENSILE STRENGTH, PSI	3200-4000
YIELD STRENGTH, PSI	3800-4000
ELONGATION, %	15-20
IMPACT STRENGTH, FT-LB/IN NOTCH AT 73°	0.6-1.0
WATER ABSORPTION, % IN 24HRS	0.1
SPECIFIC GRAVITY	1.05

YIELD PER POUND OF SHEET

THICKNESS	SQ IN/LB
040	617
060	418
080	316

Properties of high-impact polystyrene.



Samples of stamped high-impact polystyrene sheet.

cost means the fabricator gets the most area for his money in high-impact polystyrene sheet.

The fabrication of high-impact polystyrene sheet is also relatively inexpensive and may be accomplished in a number of different ways.

Punching and stamping with almost any design desired may be done, but this method of fabrication is, of course, limited to the production of flat or plane surfaced plastic parts.

A heated and softened sheet of high-impact polystyrene may be inserted between matched male and female dies which are then closed to form and cool the plastic sheet. This method of fabrication is satisfactory for some operations but is usually more costly since it is necessary to make both a male and a female mold.

Vacuum forming is by far the most common method used to fabricate high-impact polystyrene sheet. It offers the advantages of low equipment cost, high speed production, low mold costs, versatility, and rapid changeover from one job to the next.

VACUUM EQUIPMENT

Essentially, vacuum forming equipment consists of four things: (1) a clamping frame to hold the sheet, (2) a heater to soften the sheet, (3) a forming mold and (4) a vacuum system to remove the air beneath the sheet and allow air pressure to force the sheet down and around the mold. A typical cycle with this equipment might be as follows: a sheet of high impact polystyrene is clamped over a mold or a group of molds. A heater with a temperature range of 700 - 1100°F. is then placed over the sheet for about half a minute. It is important that the heater have a good uniformity of temperature to prevent localized overheating and thinning out of the sheet. The heater is removed and a vacuum applied beneath the softened sheet to draw it over and around the mold. About two seconds are required to draw the sheet and another 5-40 seconds to cool depending on the method of mold cooling.

There are many ways in which these elements may be arranged depending on the geometry of the mold, the number of pieces to be molded, and to a great extent on the ingenuity of the fabricator himself. As an example, instead of clamping the sheet over a box, and allowing the sheet to be forced down over the mold in the usual manner the sheet may be held by a clamping frame and the mold pushed up into the hot sheet with an air or hydraulic cylinder. Vacuum is then applied to pull the sheet tightly against the mold to impart the mold detail. This draping technique helps to retain greater thickness on corners and elevated portions of the mold.

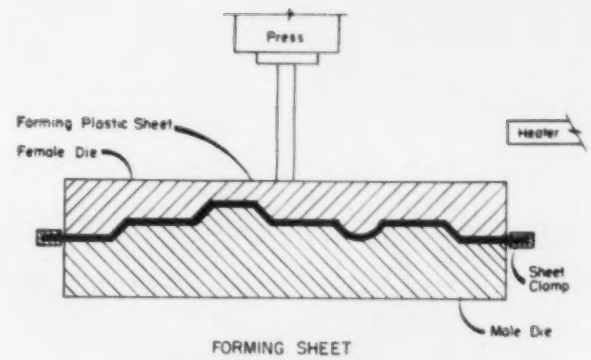
After the forming has been completed a trimming operation is usually necessary to complete the fabrication of the part. This produces a small amount of scrap which must be disposed of but this is not usually a serious problem. By proper design of the part, as well as the clamping frame and mold, the scrap can be reduced to a small percentage of the original sheet, and in some cases there need not be any scrap at all.

Small numbers of parts can be conveniently trimmed on a band saw using a skip tooth blade or a portable electric shear such as is used to cut sheet metal.

When large numbers of parts are being made a more rapid method of trimming must be used and common practice is to trim by use of blanking dies on punch presses or steel rule dies on clicker presses. These are much the same as those being used to trim sheet metal parts.

PARTS SHOULD BE DESTATICIZED

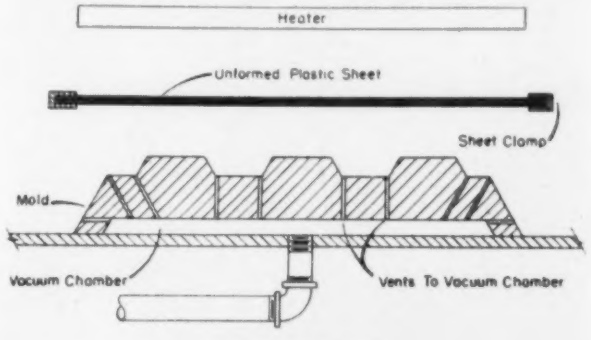
When the parts have been trimmed it may be desir-



FORMING SHEET

PRESSURE FORMING

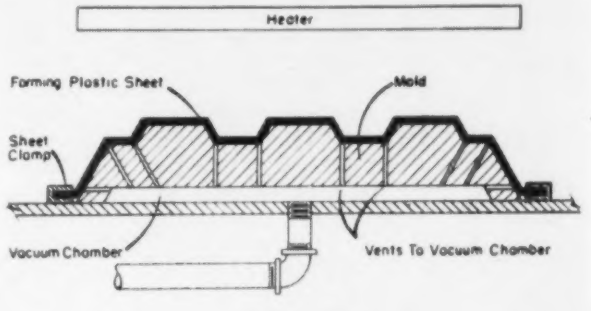
Matched male and female molds.



HEATING SHEET

VACUUM FORMING — MALE MOLD

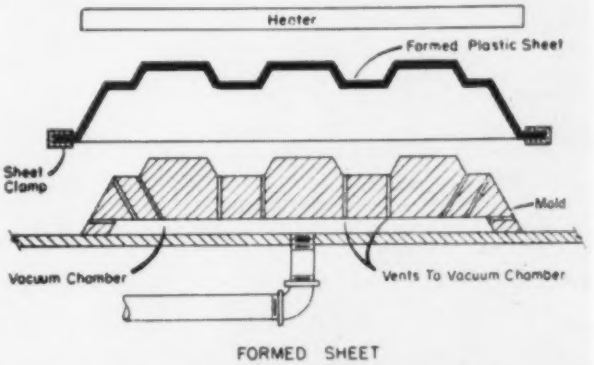
First step in a typical molding cycle.



FORMING SHEET

VACUUM FORMING – MALE MOLD

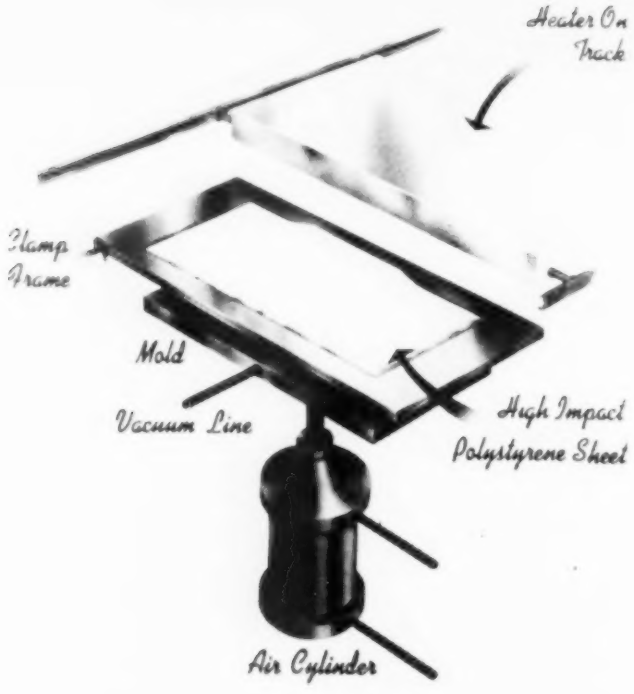
Second step in a typical molding cycle.



FORMED SHEET

VACUUM FORMING – MALE MOLD

Vacuum-forming completed, with formed part removed from the mold.



This sketch shows the "drape-forming" technique.

able to apply a destaticizing agent such as Joy or Glim to the surface of the sheet. This treatment helps to reduce the static electricity charge so that dirt and dust are not so likely to be attracted to the plastic. The important thing to remember when applying destaticizers and also when applying lacquers or enamels, is to be sure to apply one that will not attack the plastic and cause crazing and eventual failure of the part.

Decals too are quite often applied to finished parts. This is done either to label the part, such as a crisper tray for a refrigerator, or as a means of decorating the part. A decorative decal film manufactured by Di-Noc Company of Cleveland, Ohio has just recently been developed for application to high-impact polystyrene sheet. It is applied as a film over the entire surface of the flat sheet and may be vacuum formed right along with the sheet. Anything that can be photographed can be reproduced on the film and transferred to the surface of the plastic sheet.

Printing inks and lacquers have been developed by such companies as International Printing Ink Division of Interchemical Corporation and Logo, Incorporated to take advantage of the excellent printing surface offered by this sheet. It may be printed by "offset" or "silk screening". This may be done in distorted form on the flat sheet so that when the sheet is formed the printing will assume the intended proportions. This feature eliminates costly hand painting or spraying of three dimensional objects.

Nothing has been said about forming molds but they are an important part of the vacuum forming operation. It is in the making of molds that some of the greatest cost and time savings are made.

MOLD MATERIALS ARE MANY

There is a host of materials to choose from in making vacuum forming molds. Individual choice will depend on the number of pieces to be made, the mold making facilities of the fabricator, and, to some extent on the geometry of the part.

Materials such as wood, plaster, and plastic casting resins are excellent low cost materials for molds to be used for making samples and in some cases they have been used for short production runs.

Aluminum, magnesium, Kirksite, soft iron, and many other materials make excellent production run molds. These materials are relatively low in cost and the cost of machining them is low because highly polished surfaces, ejector pin assemblies and the like, are not necessary in the vacuum forming operation. Instead of waiting months for costly machining of molds, these vacuum forming molds can be finished in weeks or even days and at only a fraction of the cost of an injection mold.

In many cases these metals may be cast right over a model of the part to be made. This casting constitutes the finished mold which may then be drilled with enough small .035" holes to permit air to escape rapidly during the vacuum forming operation.

Metal spraying is an important variation of the casting technique that is rapidly gaining favor. A shell of metal can be built up by spraying a model with a jet of molten metal until sufficient thickness is built up to withstand the mild pressures involved in vacuum forming.

MOLD TEMPERATURE CONTROL

Vacuum forming molds have not, in general, been equipped to use mold temperature control in the past. Control of mold temperature is becoming increasingly important as larger and larger volume production is encountered; and as ways are sought to shorten the fabrication cycle. The formed sheet can, of course, be cooled by a blast of cool air or by a fog spray of cold water. These methods are undesirable in mass production for two reasons. First, the blast of cold air or water rapidly chills and shrinks the outer surface of the sheet while the opposite side remains relatively warm for a time. The effect is to produce internal stresses in the plastic parts and make them more susceptible to crazing and failure. Second, this method of cooling may slow down the production rate because molds and equipment having no temperature control will gradually build up heat as the hot sheets are pulled down over them until a point is reached where the cycle must be slowed down to permit the mold to cool sufficiently to allow the sheet to be removed.

Controlling the mold temperature by circulating warm water of about 125°F. through cooling coils is the simplest way to cool the sheets and it will eliminate or minimize both of the effects just noted. Parts are cooled more uniformly and have better physical properties because there will be less internal stresses. Uniform cycles can be maintained right from the time the machine is started up because excess heat is carried away from the mold, preventing it from building up in temperature.

We have touched on some of the properties, the aspects of fabrication, trimming and decorating of high-impact polystyrene sheet and a few points should be made concerning the applications and the future for this sheet.

APPLICATIONS AND FUTURE FOR SHEET

There is a rapidly expanding field of applications for this sheet and new uses are being found for it daily. The largest present users of high-impact polystyrene sheet are the refrigeration and radio-TV industries. In the refrigeration industry such items as inner door liners for freezers and refrigerators, refrigerator drip trays, crisper trays, egg holding trays, and breaker strips are produced in large volume. It is even possible now to make the complete refrigerator box liner from high impact

polystyrene sheet.

In the radio-TV field this sheet is widely used for making the masking frame around the picture tube and the rear cover on the back of the tube. These are usually made from an olive drab color sheet that was especially developed for this industry.

Radio housings too may be fabricated from this sheet.

Another rapidly growing use for high-impact polystyrene sheet is in 3-dimensional signs and displays for point-of-sale advertising. Such things as mannikins and lighted picture boxes are made from opaque sheet while internally lighted signs may be made from transparent sheet.

A few of the host of other uses for high-impact polystyrene sheet are such things as photographic print washers, packaging and display cases for many items, baffle plates for air conditioners, and toilet bowl liners for aircraft.

An unusual application making use of the cleanability of this sheet is a vacuum formed picture frame. A picture may be painted on this unit and retained as such or wiped clean ready for another picture. This is ideal for art students, and for children's finger painting.

With the multitude of uses being found, the future looks very bright for high-impact polystyrene sheet. It is expected that new and improved sheet materials, new applications, and improved fabrication techniques will continue the trend of rapid expansion and growth which high-impact polystyrene sheet is experiencing.

An experimental high-impact polystyrene sheet having a greatly improved finish on one side is being tested in the field and it appears that a pre-printed or pre-decorated sheet with a wide variety of designs to choose from may be forthcoming in the future.

Internally lighted picture box.

New and improved materials having better impact properties and greater elongation are being developed. It is expected that polystyrene will be modified in many ways and perhaps someday a transparent tough sheet material will be made available.

This far, we have been discussing sheet in a range of thickness from 40 to 80 thousandths of an inch. Indications are that this range will broaden to include thinner and thicker sheets.

New and improved materials and new applications will continue to expand the market for polystyrene sheet but manufacturers of fabricating equipment must keep pace with new equipment and new ideas to improve fabricating techniques. Perhaps equipment can be designed to heat the sheet from both sides to take advantage of

High-impact sheet printed before forming (left) and pre-printed formed sheet to make a decorative sign.

A Kirksite vacuum-forming mold.

shorter cycles and more uniform parts with less internal stresses.

The cutting and trimming of sheet represents a costly secondary operation and it is expected that continued interest in sheet materials will stimulate people to look for ways to trim the sheet while it is still hot and soft on the mold.

This interest in present improvement naturally is not all going to be centered on secondary fabrication operations.

It is believed that there will also be many improvements made in the heating and forming of high-impact polystyrene sheet as ways are sought to lower costs and speed up production. This method of fabrication is here to stay. It has proven its worth and should be considered of equal importance to the other forms of thermoplastic fabrication.

Inner-door liner for a refrigerator, complete with molded-in steel-reinforced shelves.

Paul M. Elliott
Naugatuck Chemical Co.

Paul M. Elliott

Acrylonitrile Copolymer Blends in Pipes and Fittings

The use of plastics in the manufacture of pipe and fittings is relatively new, and extensive industrial installation of plastic pipe dates back only to the end of World War II. We must agree, however, that the industry is now "established." During 1952 an estimated 17 to 18 million dollars worth of plastic pipe was produced and the production will probably total over $25,000,000 in 1953. Annual sales in the range of $250,000,000 have been forecast for ten years from now. The future of plastic pipe in our industrial picture is assured and this is not on the basis of greater availability or cheapness but on the basis of sound inherent advantages.

PLASTIC PIPE IS LIGHT in weight and thus easier to ship, store, handle, and install. It is resistant to rust, corrosions, and electrolytic action that are serious factors with many metal pipes, particularly with iron and steel which are the major pipe materials. Plastic pipe may be expected to give longer service life than metal under severely corrosive conditions. In suitable applications, well made plastic pipe properly installed will compete not only with iron and steel but with the nonferrous metals and alloys and with non-metallic pipes.

The word "plastic" like the word "metal" is a generic term. There are several types of plastic materials suited to the manufacture of pipe and fittings. Each has its own advantages and its limitations. This paper will discuss the properties, processing, and potentialities of one particular series of compounds—that based on blends of styrene-acrylonitrile copolymer resins with butadiene-acrylonitrile copolymer rubbers. The styrene-acrylonitrile copolymers are hard, relatively tough, chemically resistant plastics with relatively high temperature resistance. The inclusion of acrylonitrile in the system has raised the heat distortion point of the copolymer some 35 F over that obtained with straight polystyrene. The butadiene-acrylonitrile rubbers are well known for their chemical and oil resistance. Blending of these two systems has resulted in a gum-plastic or alloy which not only has the chemical resistance and heat resistance of the components but has toughness and impact resistance to an astounding degree. Such a combination of properties in a plastic that can be both extruded and injection molded has permitted the production of lightweight, rigid, chemically resistant pipe and fittings which set new standards of toughness and impact resistance.

The data obtained in the physical testing of these acrylonitrile copolymer blends by standard methods are presented in table I. The figures show the range of properties obtained with Kralastics B and BE, the commercial grades of the copolymer blends that are generally used in pipe and fittings. Particularly to be noted are the high notched impact, the excellent hardness and stiffness or modulus, and the high heat distortion temperatures shown by these materials. Our experience has indicated that these properties are generally maintained in extruded and molded products.

EXTRUSION IS STILL AN ART

Extrusion is still to be classed as an art rather than a science although much theoretical work has recently been done or is now in progress. Recommendations for processing are therefore based on experience rather than calculation. Although Kralastic has been extruded in most types of commercially available extruders, best results have been obtained with single flight, constant pitch compression type screws with from 2.5 to 1 up to 3.5 to 1 compression ratio. Polished steel or chromium plated dies and pins are satisfactory and in general should have land lengths about equal to pipe O.D. up to 3 or 3½ inch pipe. Above this limit land lengths are kept constant at 3 to 3-½ inches. Dies are generally 10 to 15% oversize to permit drawdown. A single sizing ring is generally used and may be placed at the entrance to a water bath or may be followed directly by a water cascade. In larger sizes the water cascade method of cooling the pipe is recommended because of the troubles otherwise experienced in submerging the pipe without undue distortion. For satisfactory results it is essential that the pull on pipe as it flows from the die and through the sizing ring be steady and even, therefore a good capstan or take-away is required. The pull required for larger size heavy wall pipe (4 inches and up) may be in the range of 600 to 800 pounds, so that powerful well-made equipment is necessary.

The appearance and physical properties of the extruded product are the best criteria for setting operating conditions. Actual indicated temperatures may vary considerably from machine to machine but in general should be set so that the stock temperature at the die will range from 370 to 400 F.

TABLE I

Range of Physical Properties for Acrylonitrile Copolymer Blends Kralastics B and BE

Izod Notched Impact	5-10 ft. lbs./in.
Flexural Modulus	300,000 psi
Flexural Strength	8500-9000 psi
Tensile Strength	4000-4500 psi
Heat Distortion, 264 psi	180-187 F
Water Absorption, 24 hr	0.2-0.3%
Rockwell Hardness	R92-R96

TABLE II

Approximate Kralastic Throughput for Extruders

Screw Diameter	
1½ in.	25 lbs./hr.
2½ in.	50 lbs./hr.
3½ in.	100 lbs./hr.
4½ in.	200 lbs./hr.

The through-put or production rate of an extruder will vary with actual design features but the expected maximum through-put of Kralastic for various size extruders is as shown in table II. From such figures one may readily calculate the production of an extruder in terms of feet of pipe per minute for any desired size of pipe. Figure A shows graphically the production rates that might be expected for standard IPS-40 sizes.

FITTINGS FOR PIPE

Fittings for the acrylonitrile copolymer blend pipe can be made readily by standard injection molding techniques from Kralastic B. Molding conditions will vary widely depending on machine, mold design, shot size, gating and the like, but some generalizations can be made. Cylinder temperatures affect to some degree the physical properties of the molded piece. Maximum impact and flexural strength and best surface appearance are obtained with cylinder temperatures as low as practicable. On the other hand high cylinder temperatures give higher heat distortion temperature, better welding, and faster filling. Mold temperatures should be as high as is reasonable without excessive lengthening of molding cycles since hot molds (140°-190 F) give optimum surface luster and heat resistance. Gates should, in general, be large and should be fed with large runners and nozzles to insure rapid filling of the mold.

Acrylonitrile copolymer blend pipe and fittings have the many general handling advantages of plastic pipe and several special advantages. The pipes, which are frequently made in standard iron pipe sizes, weigh only about one-seventh as much as the corresponding iron pipe and so can be handled more readily, stored more easily, and shipped much more economically. The pipe is rigid but can be cut easily with an ordinary handsaw. If threaded fittings are used the pipe may be threaded readily with any pipe-threading machine and has excellent machining qualities. For thin wall pipe and tubing solvent-weld type fittings are available which can be cemented rapidly in the field. Other special fittings such as Dresser, Victaulic and expansion fittings are available from various manufacturers. The pipes may be bent if heated to 200 to 220 F. Some manufacturers are now producing special valves made from the acrylonitrile copolymer blend compounds so that complete corrosion resistant systems may be installed.

PERFORMANCE DATA ARE USEFUL

The data presented earlier were obtained by standard test methods using standard shaped test bars prepared in the laboratory from flat compression molded sheets, injection molded bars, or extruded bars. Parallel tests have been run for several properties on samples made by all three methods and the agreement is in general very good indicating that the properties listed are representative of those of the material. It is possible, however, to alter the properties of the materials in the direction of either higher or lower values by control of processing conditions. It becomes necessary and highly desirable therefore, to get what might be called performance data. Here again there are two types of data first, tests on pipe performed under controlled conditions so as to give numerical values; and second, tests which are really service records on commercial installations. Data of the first type are now being accumulated but almost complete lack of accepted methods for testing is slowing the process and makes interpretation of results difficult. Results of simple burst tests are among the first data obtained. Values will vary with the rate of pressure buildup, the temperature, the dimensions of the pipe, and other factors. Typical burst values range as shown in table III. The range in burst pressures is wide and correlation is difficult. Recourse has therefore been made to formulas which, by expressing burst strength in terms of the tensile constant of the material and the dimensions of the pipe, have permitted correlation of data obtained on pipe of different dimensions. The formulas also permit calculation of burst strength for sizes of pipe not available for test.

Two common formulas (Table IV) are used to calcu-

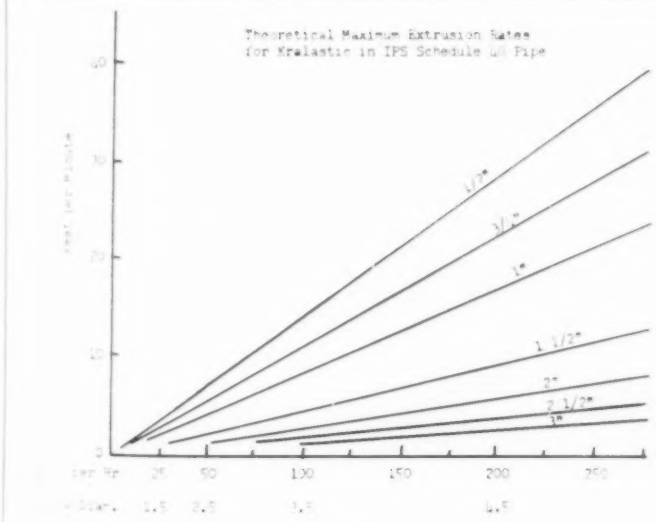


Figure A.

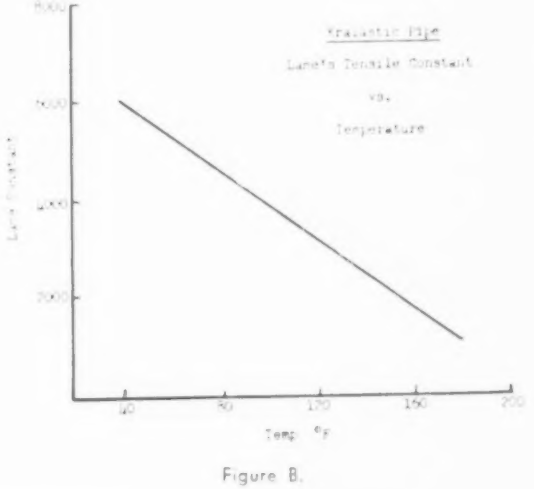


Figure B.

late burst. The simpler Barlow formula takes into consideration only the radial stresses in the pipe which of course lead to tensile stresses in a circumferential direction. The more complex Lame formula is derived in such a way that the longitudinal stresses are also considered. This formula is probably a bit more conservative. It represents the results that would be expected in service or in testing with free capped ends and, most important of all, it has been found in our experience to give best agreement with experimental data when several sizes of pipe are tested and the tensile constant is calculated. The tensile constant is not necessarily the same as the tensile determined by standard ASTM methods and the exact value of the constant will vary with the testing technique. For instance, on a given type of pipe, constants as determined from tests made in different labs have ranged from 4000 to 5000. Study of testing variables will no doubt show up the reason for this variation.

TEMPERATURE VARIATION OF TENSILE

Using the Lamé formula to calculate the tensile constant we have studied the variation of this constant with temperature. A typical curve is shown in Figure B. The change in tensile constant has seemed to be a straight line function with temperature. Meager data indicate that the slope may be somewhat dependent on test methods but that if the method is held uniform the function is a straight line within the temperatures tested.

In running burst tests it has been observed that Kralastic pipes when subjected to gradually increasing pressure will withstand a peak pressure some ten to fifteen percent above ultimate burst before they begin to swell markedly. Nevertheless it has been general practice of pipe manufacturers to recommend as safe working pressures a figure which is never more than 25% of the burst pressure and is usually less than 20% of burst. This gives a "factor of safety" or 4, 5, 6 or more to 1.

Another advantage for plastics pipe in general which has been confirmed for the acrylonitrile copolymer blend is the relative advantage in the rate of flow or in decreased loss in head of liquid flowing through the pipes. A series of tests using liquids of various viscosities has indicated that when the rate of flow is rapid enough to give turbulent flow the loss of head per unit length of pipe at any given rate of flow is only about 50% as great with the acrylonitrile copolymer blend pipes as with ordinary steel pipes. This factor may be taken advantage of in any one of several ways giving either greater flow through longer pipes of a given size, or saving in power requirements for pumps, relative to what might be experienced with ordinary metal pipe.

Their combination of toughness and chemical resistance has lead to the installation of acrylonitrile copolymer blend pipes in many locations where internal and/or external corrosion has been a problem. Well engineered and well installed systems have been giving trouble-free service for many months in locations where ordinary metal pipe was unsuited or short-lived. Among industrial installations exposed to acid conditions we find piping systems that have handled 5% sulfuric acid for 2 years; battery acid for 1 year; and a mixture of 2% copper sulfate, 4% ferric sulfate, 2% aluminum sulfate and 4% sulfuric acid for 16 months. Alkali resistance is shown by a system handling 20% sodium hydroxide for 2 years, and another handling sodium hypochlorite with 15% available chlorine for 16 months. Dry chlorine gas has been handled without trouble for 2 years and several more recent installations have been made for handling wet chlorine gas. These installations are all still in service and have shown no signs of failure due to physical deterioration or chemical attack. In the many cases where glass, brittle plastic or hard rubber pipes have been replaced by the acrylonitrile copolymer pipe the accidental breakage so frequent with the more fragile materials has been eliminated.

Oil fields use staggering amounts of pipe and much of it is subject to corrosion by brine or sour crudes internally and to acid, salt, and electrolytic corrosion externally. Here again the acrylonitrile copolymer blend pipe has proven highly successful. Typical satisfactory installations include a 4500 foot 3 inch line carrying brine at 110 F and subject to vacuum up to 28 inches. A previous line made of another type plastic collapsed in 6 weeks; the acrylonitrile copolymer line is still good after one year. A 4100 foot line of 3 inch pipe operating at 120°F and 20 pounds and buried as much as 20 feet shows no failure after one-and-one-half years. A 400 foot 2 inch line operating where corrosion and paraffin had been a serious problem has given no trouble in 16 months. In another trouble spot where corrosion and paraffin caused metal pipe replacement in about 60 days a 400 foot acrylonitrile copolymer blend line has been in service for 18 months.

The list might be extended to mention installations in mines, paper mills, sewage disposal plants, water treating plants, food handling plants, and many others, but this listing is sufficient to show that the acrylonitrile copolymer blends have permitted the production of a plastic pipe of easy handling qualities, superior chemical resistance, freedom from toxicity, high heat distortion, and outstanding toughness which holds great promise in many fields of applications.

TABLE III

Room Temperature Burst Values

	½" pipe	4" pipe
Solvent Weld Line Pipe	950	400
IPS Schedule 40	1400	500
IPS Schedule 80	1750	650

TABLE IV

Barlow's Formula

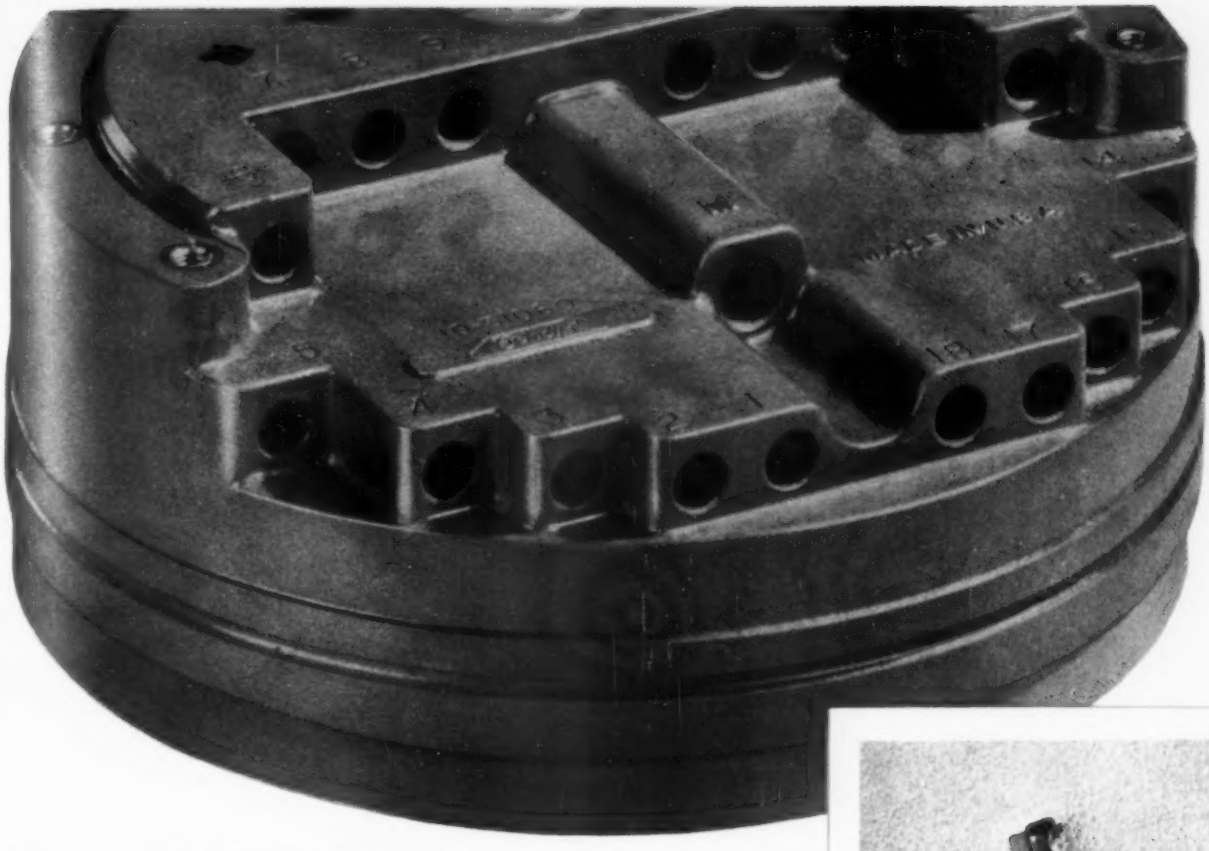
$$\text{Burst} = \frac{2 \times \text{Tensile Constant} \times \text{Wall Thickness}}{\text{Outside Diameter}}$$

Lame's Formula

$$\text{Burst} = \text{Tensile Constant} \quad \frac{OD^2 - ID^2}{OD^2 + ID^2}$$

OD = Outside Diameter

ID = Inside Diameter



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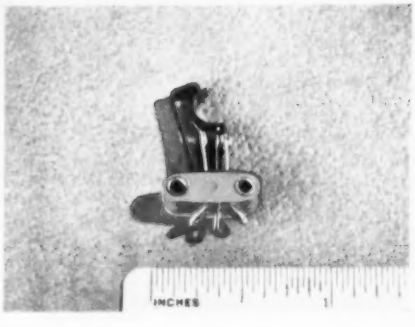

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Styrene Acrylonitrile Copolymers

by J. S. Whitaker

Bakelite Company

Division of Union Carbide and Carbon Corp.

Attractive holders for paper cups molded of tough copolymer resin

Acrylonitrile is a versatile monomer capable of polymerizing with itself and with many other vinyl derivatives including styrene. When it is allowed to polymerize with styrene, the resulting copolymers are rigid transparent materials having chemical and mechanical properties different from those of either polystyrene or polyacrylonitrile. The magnitude of these differences follows the ratio of monomers in the copolymer: those containing small quantities of nitrile approach the properties of polystyrene; the very high acrylonitrile copolymers approach the limited solubility and almost non-moldability of polyacrylonitrile. Between these two extremes is an area where the copolymer has many of the advantages of and some improvements over the familiar polystyrene and polyacrylonitrile. These copolymers have higher mechanical strengths, better weather resistance, and generally improved chemical properties over polystyrene. They differ from polyacrylonitrile in that they can be molded, extruded and calendered into a variety of useful shapes with conventional equipment.

Several acrylonitrile-styrene copolymers are available as commercial products. One of these is BAKELITE BMC-11, or C-11. Since most of the technical information available to the author has been obtained using this material, reference to C-11 will be used for purposes of illustration.

Much of the existing injection molding equipment installed for the molding of polystyrene can be used for acrylonitrile-styrene copolymers. There are some viscosity differences which require an upward adjustment of both the cylinder and the mold temperatures for the copolymer over that ordinarily used for polystyrene. The extrusion plastometer data in Table I and the Rossi-Peakes flow data in Table II clearly illustrate the relative stiffness of the two materials at 390 deg. F. and 265 deg. F.

A modified ICI Grader, or extrusion plastometer, can be used to give an indication of the relative plasticity of materials in the injection molding cylinder. These data are significant with relation to the ease of moving material through the cylinder. Tests conducted on the two materials at 320, 355, 390 and 430 deg. F. and 100 psi gave the following results in milligrams per minute using a plastometer having a 0.085 inch orifice and a land length of 0.312 inch.

TABLE I

Extrusion Plastometer Data

Material	320°F	355°F	390°F	430°F
Acrylonitrile-Styrene Copolymer (C-11)	1.3	10.6	63	232
Polystyrene				
Typical Monofilament Grade	2.2	15.8	68	222
Unlubricated General Purpose	10.4	58.0	227	699
Free-Flowing General Purpose	21.3	97.0	346	979

It can be seen from these data that the copolymer is about as fluid at 390° F. as is general purpose styrene at 355° F. under the conditions of this test. While these relative values amplify differences in stiffness and, therefore, are not directly applicable to molding conditions, they correctly indicate that higher cylinder temperatures are required for the copolymer in order to achieve a plasticity equivalent to that of general purpose polystyrene.

Rossi-Peakes flow data are another indication of relative stiffness when materials are heated as they are forced through a small cylindrical opening. This pro-

is almost the reverse of forcing hot material from an injection cylinder into a colder mold; but it is indicative of relative mold temperature requirements to effect mold fill-out in long-drawn, thin sections. Here again a higher temperature is indicated for the copolymer in order to achieve the same flow in a given die. This relationship will vary widely depending upon the size and shape of the pieces being molded—practical experience has shown the range to be a 20° to 40° F. increase for C-11.

TABLE II

Rossi-Peakes Flow Data

Material	Seconds to Flow 1.5 inches at 265°F. and 1,000 psi
Copolymer C-11	Over 500
Polystyrene	
Monifilament Grade	270
Unlubricated General Purpose	125
Free-flowing Grade	65

Another test value useful for comparing the moldability of materials is the minimum pressure required to fill a mold. For such a test, Bakelite Company has used a 12-ounce Lester Machine in which was mounted a combination plaque and test-bar mold. The molded piece weighs 10 ounces and has a surface area of 102 square inches. With a material temperature of about 480° F. and a mold surface temperature controlled by means of circulating liquid, the typical values shown in Table III were obtained for the C-11 and the three grades of polystyrene used in the previous tests.

Typical molding conditions for three acrylonitrile-styrene commercial items are summarized in Table IV. Molds used for these items were designed on the basis

TABLE III

Minimum Pressures to Fill a 102 Square Inch Plaque Mold

Material	Stock Temperature (deg. F.)	Mold Temperature (deg. F.)	Pressure (psi)
Copolymer C-11	480	176	12,000
Polystyrene			
Monofilament Grade	480	158	13,100
Unlubricated General Purpose	480	158	11,200
Externally Lubricated General Purpose	480	158	9,000
Free-Flowing Grade	480	158	7,500

of experience with standard grades of polystyrene. Production with acrylonitrile copolymer did not present any major molding problem or necessitate major changes in the molds as originally built.

The beauty shop hair drier is a good example of a large area molding where complete fill-out is a problem. Its diameter measures 12 inches; it is 9 inches high at the center; and it has a wall thickness of $\frac{1}{8}$ inch. Heavier cross sections such as an oil filter sight glass with a $\frac{3}{8}$ inch wall have been molded without sink marks or bubbles.

The copolymers have been used for these and many other molded consumer items because of their practical toughness, excellent dimensional stability, moderately good weather resistance, resistance to oils and greases as well as to many common cleaning materials such as soaps, detergents and carbon tetrachloride. One or more of these properties are important for such applications as airline dishes and trays, cutlery handles, draftsmens instruments, institutional dishware, tumblers and cups, radio and TV

TABLE IV

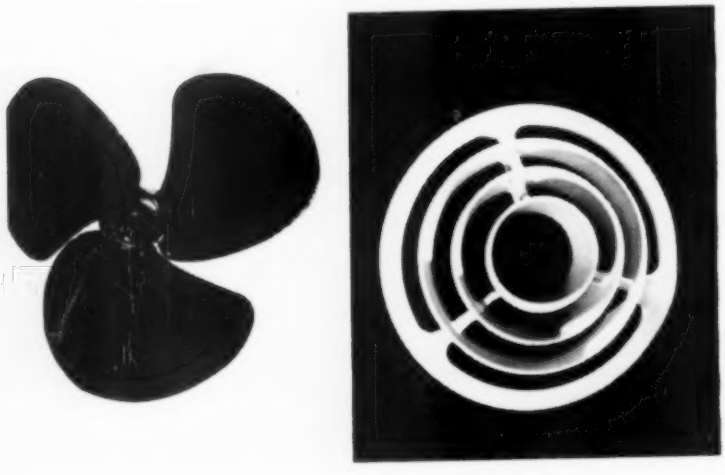
Typical Conditions for Molding C-11

Item Molded	Camera Housing	Television Lens		Hair Dryer Housing	
Machine	12 oz. Lester	24 oz. Watson Stillman with preplasticizer		24 oz. Watson Stillman with preplasticizer	
Number of Cavities	2	1		1	
Weight of Shot (oz.)	9.04	96.56		48.28	
Overall Cycle (sec.)	70	120		80	
Temperatures (deg. F.)					
Injection Chamber	Rear: 560 Front: 530 Inner: 550	Preplasticizer Rear: 475 Front: 440 Inner: 475 Nozzle: 445	Inj. Cylinder Rear: 475 Front: 425	Preplasticizer Rear: 360 Front: 360 Center: 360	Inj. Cylinder Rear: 375 Front: 375
Die	170 to 180	160 to 170		220—Movable Side 190—Stationary Side	

TABLE V

Physical Property Data

	BMC-11	High Impact Polystyrene	Rigid Vinyl	Polystyrene
Flexural Strength (psi)	17,000	6,500	13,000	14,000
Modulus (psi x 10^{-5})	4.5	3.2	4.5	4.5
Impact Strength (ft-lb.)	0.5	2	0.5	0.35
Heat Distortion (deg. F.)	195	176	150	185
Water Absorption (per cent in 24 hrs.)	0.2	0.12	0.07	0.03
Specific Gravity	1.08	1.05	1.4	1.05



coil frames, refrigerator components, fountain pen barrels, and automobile sun visors.

A comparison of the properties of the copolymer with rigid vinyl, which it resembles in chemical and electrical properties, and with other types of thermoplastic styrene materials is shown in Table V.

Acrylonitrile copolymer loses strength at elevated temperatures in typical thermoplastic fashion. However, the energy required to break it does not undergo the sharp decline at about 140° F. that is characteristic of polystyrene. Flexural data for the temperature range 80° F. to 180° F. illustrating this striking difference are given in Table VI.

At -50° F. copolymer C-11 is substantially stronger in flexural and tensile strength than at room temperature. The values are 31,000 and 15,000 psi, respectively. Flexural work to break at -58° F. is 6.6 foot-pounds per cubic inch. Thus, the energy required to break a molded flexural bar is higher at elevated temperatures and at low temperatures than it is at 80° F.

Acrylonitrile-styrene copolymer has been calendered on conventional equipment regularly used for vinyl compounds. Temperatures in the range of 290° to 315° F. are used to produce C-11 sheets up to about 20 mils in thickness. These in turn can be pressed-polished or laminated into thicker sheets. A typical press-polish cycle requiring seven minutes of pressing at 374° F. using 165 pounds per square inch has given sheets with a low order of shrinkage. Best results are obtained if the sheets

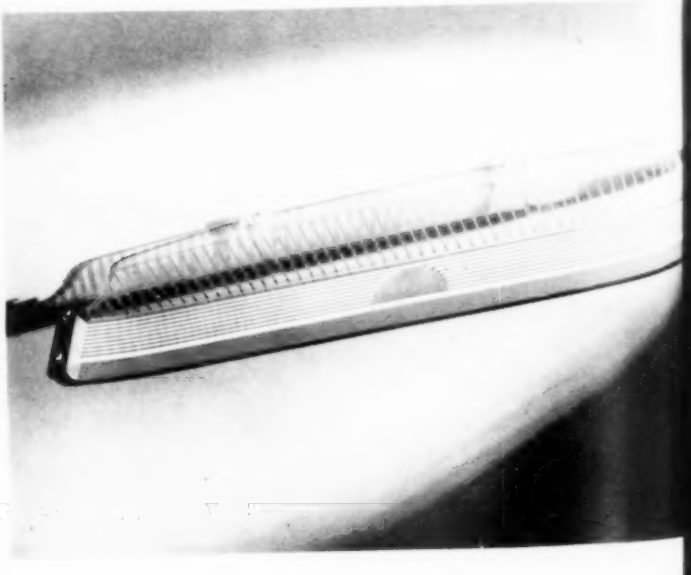


TABLE VI

Flexural Properties of Acrylonitrile-Styrene Copolymer

	Flexural Strength (psi)		Flexural Work to Break (ft. lb. per cu. in.)	
	C-11	Polystyrene	C-11	Polystyrene
80 deg. F.	17,000	14,000	3.0	4.0
100 deg. F.	17,000	13,000	3.5	3.5
120 deg. F.	16,000	12,000	3.8	2.5
140 deg. F.	14,000	10,000	4.0	2.0
160 deg. F.	13,000	8,000	4.2	1.0
180 deg. F.	10,000	7,000	4.0	0.8

TABLE VIII

Extrusion Characteristics and Condition for Polystyrene and C-11 Resins

	Rod			Pipe			Monofilament	
	A	B	C	A	B	C	B	C
Size	0.550" to 0.575" Dia.			0.750" o.d. x 0.095" Wall			0.016" Dia.	
Extrusion Temp. °C.								
Worm	Neutral—No Water or Steam							
Feed Section	30	30	30	30	30	30	Cold Water	
Rear	175	175	175	175	175	175	175	
Center	240-255	255	225	240-255	250-260	225	255	
Front	260-285	280	245	260-290	275-300	245	300	
Torpedo	260-285	290	250	265-290	280-300	260	305	
Head	270-295	295	250	275-300	290-315	275	310-315	
Die	275-300	300	255	280-305	295-325	280	315-325	
Stock Temp. °C.	250	260	240	255-260	265-270	255-260	295-300	255
Extrusion Rate lb/hr. at Worm Speed of								
15	22.5	21.1	21-27	24.4	19.0	20-27	20	20-25
20	29.7	26.8	27-34	30.3	24.7	25-33	-	24-30
25	39.0	34.3		39.3	32.7	-	-	29-38

Note: A Polystyrene—Unlubricated General Purpose
B Polystyrene—Typical Monofilament Grade
C Acrylonitrile—Styrene Copolymer

are removed from the press at temperatures between 175° and 212° F., and then cooled in air. Trimming of sheets at the calender requires a little more care than is necessary with vinyl. Trimming knives should be positioned so that they contact the sheet while it is still hot in order to eliminate shattering.

Typical properties of ¼ inch press-polished sheets are summarized in Table VII.

TABLE VII

C-11 Press-Polished Sheet Stock

	78 deg. F.	150 deg. F.
Tensile Strength (psi)	11,500	6,000
Tensile Modulus (psi x 10^{-5})	5.0	4.6
Yield Strength (psi) @ 0.2 per cent offset)	9,500	4,500
Elongation at Failure (per cent)	4	20
Flexural Strength (psi)	17,000	10,300
Flexural Modulus (psi x 10^{-5})	5.2	4.3

At present, the largest percentage of these compounds produced are being consumed in the injection molding field. However, acrylonitrile-styrene monofilaments have been used for several years in areas where grease resistance and high strain-release temperatures are required. Current interest in other extruded shapes is increasing.

Typical extrusion data are shown in Table VIII, where the conditions for forming thin oriented monofilaments and typical thicker sections are given in detail for two commercial grades of polystyrene and C-11. The polystyrene and copolymer used in these extrusions were preheated for one and three hours, respectively, at 194° F. While this drying is often optional for polystyrene, it is a requisite for the more hygroscopic acrylonitrile copolymer.

The data given in Table VIII have been compiled using a No. 1 Royle, 2-inch extruder equipped with an electrically heated head. These relative extrusion conditions will serve as a guide for temperatures required for other shapes.

(continued on page 54)

applications

FOR RUBBER MODIFIED STYRENE MOLDING COMPOUNDS

Edwin V. Hellyar
Monsanto Chemical Co.

In 1939, the then new styrene injection molding industry consumed approximately 1,000,000 lbs. Initially, costs were high, but due to chemical resistance and electrical properties, almost all of these 1,000,000 lbs. went into liquor pourers and electrical insulation components. Styrene is inherently a low cost material and as volume increased, selling prices were reduced. Injection molding permitted low manufacturing costs and the use of styrene for novelties, trinkets and gadgets followed.

Wartime shortages of various materials, particularly metals, resulted in many new uses for styrene, while at the same time styrene was being adopted for applications where its inherent properties were recognized as superior to other materials. Growth was rapid, and in 1953 total industry sales in the range of 300,000,000 lbs. were enjoyed.

The excellent dimensional stability, low moisture absorption, thermal and electrical properties, light weight, transparency, unlimited color range and ease of moldability of styrene all contributed to this excellent growth picture. However, its greatest weakness, lack of strength, was recognized as a limiting factor and in 1949 rubber modified styrene molding compounds as we know them today were introduced. These modified materials, referred to as "medium and high impacts," accounted for over one-third of total industry sales of styrene molding compounds in 1953.

While retaining essentially all of the properties of general purpose styrene, the rubber modified compounds add strength and toughness, properties which open an almost unlimited field of application to the styrene injection molding industry. Although still referred to as "impacts", these compounds possess other improved properties, including ultimate elongation and flexural fatigue, resulting in toughness required for many industrial applications.

The future for rubber-modified styrene molding compounds is a bright one. Whereas the growth curve for general purpose material is flattening out, the projected curve for the modified compounds indicates continued growth to the point where it is estimated consumption will approach 300,000,000 lbs. by 1960.

We may look for this growth along three definite lines:

1. Replacement of general purpose in current applications.
2. Expanded use in already established applications.
3. New applications, known and unknown.

Portable radio (above) and table model radio (right) cases made of rubber-modified polystyrene.

TOYS AND HOUSEWARES

Toys and housewares are the two largest established end uses for styrene. An estimated 60,000,000 lbs. went into toys in 1953, and approximately 50% of this was general purpose material.

Toy industry sales totaled $900,000,000 in 1953, and there is no question but that sales will continue to grow. The so-called "great birth boom" assures this. The Census Bureau estimates that there are now 67% more children under five years of age than there were in 1940, and 49% more children in the five-to-nine year old bracket as compared with 1940. The potential for modified styrene in toys is obvious.

Consumer resistance to plastic toys, due to breakage, makes it mandatory that the tougher modified materials replace general purpose styrene. The lowered costs at which these materials are now available makes this change economically feasible and it is safe to predict that reduced quantities of general purpose material will be used for toys in the future.

We must bear in mind, however, that there is a serious consumer resistance problem and any tendency to skimp on material as the result of a switch to modified compounds can be disastrous. On the contrary, toy molders, in addition to adopting these tougher materials, should give serious thought to improved design, resulting in even more rugged toys.

In housewares, the story is approximately the same as for toys. This is an already established high volume application for general purpose styrene, and an estimated 60,000,000 lbs. went into housewares in 1953.

There is a very definite trend to rubber-modified compounds for housewares and this trend must continue so that stronger products may be offered to combat the inroads being made by polyethylene in this field.

Rubber-modified styrene is recognized as an excellent engineering material by designers. It permits economies in manufacturing costs and wide latitude in functional design, factors which loom more and more important as manufacturers recognize that tough competition is now a hard fact. The theory of design used to be that "form should follow function", wherever the road led. Manufacturers learned that shape affects merchandising appeal considerably, and they are now turning to their design engineering departments as the first line of defense against the stiff competition ahead. Design for appearance, however, must not overlook functional aspects, and in injection molded rubber-modified styrene the engineer knows he can achieve both at minimum cost.

Development of large injection equipment now permits the engineer to specify large-area molded parts. Continued improvements in preplasticizers, and even larger presses, with increased injection speed for the production of large-area, thin-section castings, will permit almost unlimited horizons.

REFRIGERATORS AND HOME FREEZERS

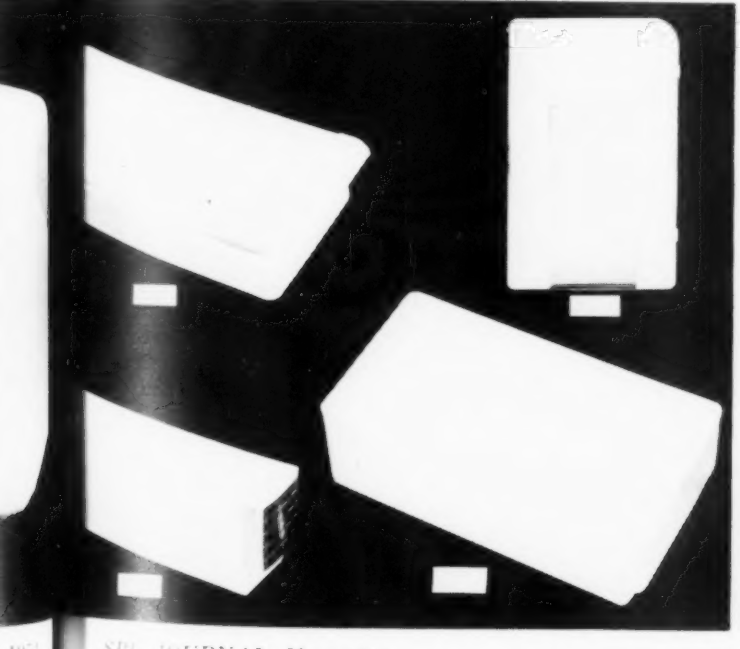
The use of rubber-modified compounds in refrigerators is well known. 3,500,000-4,000,000 refrigerators were sold in 1953 and an estimated 50,000,000 lbs. of styrene were consumed by the refrigerator industry.

Although the domestic refrigerator market is reported as approximately 90% saturated, actually there is no such thing as a fully saturated market. As soon as a market appears to be saturated, a new design or an added service makes obsolete many of the units in use. This is particularly true in refrigeration. Colored interiors are now popular, new and improved insulating materials result in smaller refrigerators, with larger cubic content capacity—a deepfreeze compartment is now almost a necessity—automatic defrosting is desired by the housewife, and the new "ice-maker" trend, all tend to minimize cold statistical percentages which indicate that appreciable growth in domestic refrigeration is not to be expected.

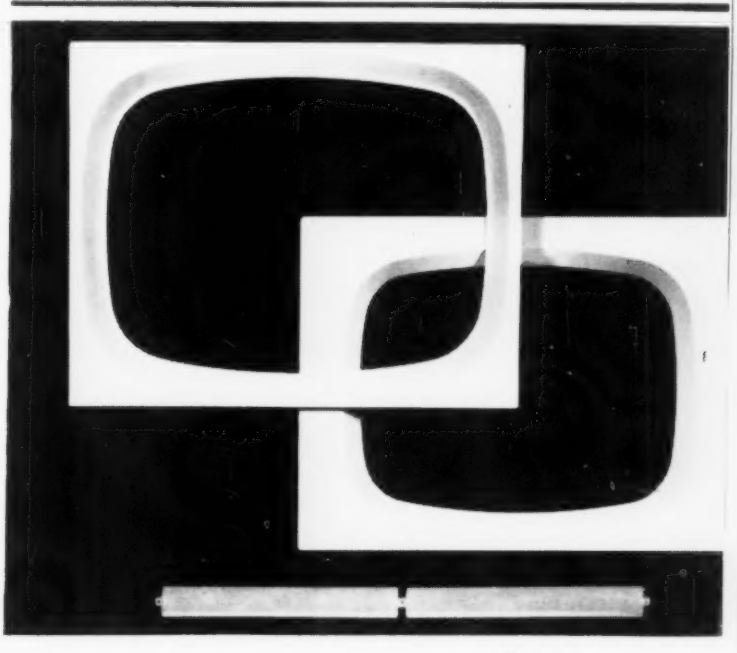
The home freezer market, on the other hand, is reported at only approximately 12% of saturation. This is definitely a growing market and in 1953 sales were in the range of 1,400,000 units.

Forecasts vary, but based on expected rise in population, increase in national payroll, upswing in new family group formations and the replacement market, predictions made by manufacturers of refrigerators and home freezers are optimistic and major plant expansions

Refrigerator meat tray, freezing unit door, storage tray and vegetable tray.



Television screen frame.



are currently under way as concrete evidence of this favorable outlook.

It is indicated that by 1960 sales of refrigerators will be between 5,000,000 and 6,000,000 units and home freezer sales will grow to 2½ to 3,000,000 units during this same period. Manufacturers are now using injection molded inner door panels of rubber modified styrene, substantially increasing the poundage consumed in each refrigerator. Several models average almost 20 lbs. per box and some manufacturers' models use over 30 lbs. of styrene, most of it rubber modified—representing about 10% of the total weight of the refrigerator. Current consumption is for larger inner door panels, breaker strips and frames, freezer compartment doors, crispers and various other smaller component parts. We believe we may look forward to seeing the average consumption substantially increased by adoption of injection molded inner linings and shelves.

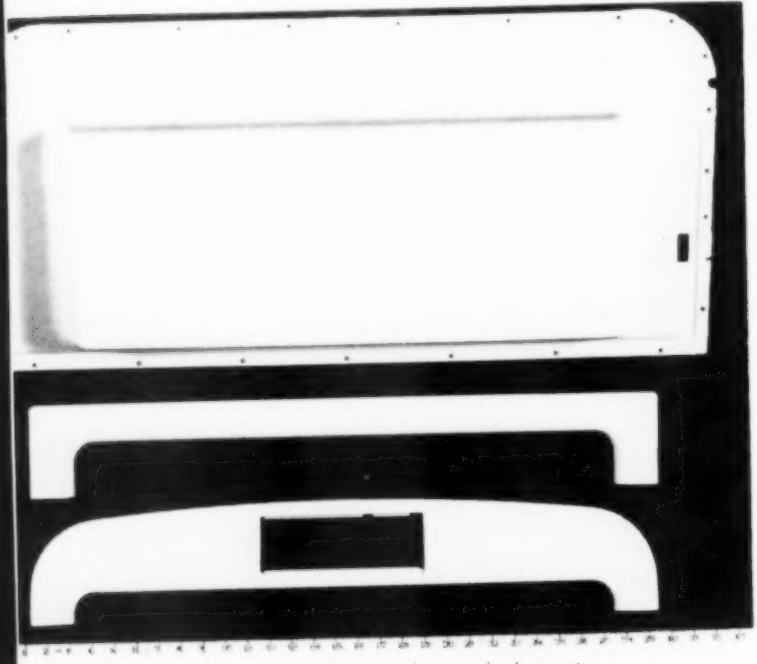
This optimism on the part of refrigerator and home freezer manufacturers, and our expectation that there will be a substantial increase in the average pounds per box, leads to the conclusion that this field of application will continue to be a most lucrative one.

AIR CONDITIONERS

In 1952, consumer demand for room air conditioners began to take hold. 341,000 units were sold, and in 1953, as manufacturers geared to meet growing demand, sales in the range of 900,000 units were enjoyed.

With an index of less than 1½% saturation, many new-comers entered the field and in 1953 there were 70 companies making or putting their labels on room air conditioners—three times as many as the year before. It is expected the number will be over 90 by mid-1954. Actual manufacturers have grown from 20 to approximately 40.

An estimated 3,000,000 lbs. of rubber modified styrene went into room air conditioners in 1953. An excellent future is predicted. Sales of 1,500,000 to 2,000,000 units are forecast for 1954 and the most optimistic forecasts indicate that by 1960 room air conditioner sales will be near the $1,000,000,000 mark. In terms of units, sales of 3,000,000 to 4,000,000 are predicted for 1960.



Refrigerator door and trim parts.

Injection molding makes it possible for cabinets to be produced in a variety of designs and permanent colors, to fit any style of home or office decoration. In addition, plastic parts are strong, yet light in weight, easily cleaned, and have corrosion resistant features which are important in this application. Many manufacturers are using fronts, grills and other component parts molded from rubber modified styrene and there is a growing trend to molded housings.

In 1953, one manufacturer adopted a one-piece injection molded housing weighing over six pounds.

As sales of room air conditioners continue to grow and the average pounds per unit continue to increase over the present three to three-and-one-half pound figure, an attractive future for rubber modified styrene seems assured.

HOUSINGS

The potential market for injection molded rubber modified compounds in many types of housing is tremendous. Although this is a relatively untapped market, several manufacturers are already using molded housings —reportedly with great success.

A new dehumidifier was recently introduced with a molded housing weighing just under four pounds. Although sales of dehumidifiers in the past have not represented a high percentage of appliance sales, there is a growing demand. Portability is an important consideration and here, again, the properties of modified styrene meet all requirements, including light weight, strength and moisture and corrosion resistance, as well as integral color and unlimited functional design opportunities.

In office appliances, we have opportunities for developing a most fertile field. A recently introduced adding machine, completely housed in modified styrene, has met with great success from both functional and decorative standpoints. The complete machine is approximately 10 lbs. lighter than competing models, making it suitable for portable use and for easy handling by women.

This housing replaced diecast metal and, in addition to being lighter and more decorative, is less expensive and offers better protection against damage to internal mechanical parts. The manufacturer has made plans for a more widespread adoption of molded housings and predicts that within a short time the inherent advantages will lead to a complete change-over in the housings of their entire line of business machines.

This is the experience of only one manufacturer in the office appliance field. It is apparent that a concentrated effort to develop this field is well-justified.

Molded housings for portable phonographs are comparatively new. A newly introduced model is three pounds lighter and appreciably smaller than a comparable wooden model in the same price category. From the standpoint of performance, the plastic housing is far superior to wood. Again, inherent properties of the rubber modified compound have resulted in a compact streamlined phonograph; smaller, lighter and definitely more attractively designed than comparable wooden models. In addition to the housing, a molded motor board with grill is also used. The total weight of case and motor board is approximately two pounds.

This is another market where a good promotional job should result in widespread adoption of injection molded rubber modified housings.

ELECTRIC FANS

The growing air conditioning industry has not hurt the sale of electric fans. On the contrary, it has stimulated the market and in 1953,—3,000,000 to 4,000,000 units were sold.

There are many types of fans and several of these are good potential applications for injected-molded housings. The window, hassock and desk types show greatest promise. Many new models will be introduced this year, with emphasis on design and utility. Molded housings offer unlimited design possibilities, with practical utility, and we should not overlook this $100,000,000 market.

RADIO AND TELEVISION

The radio and television industry is a large user of styrene, as we all know. In small radios, general purpose and heat resistant materials are generally used. However, the desire for a more sturdy cabinet is leading some manufacturers to rubber-modified compounds, particularly for portables.

Between 6,000,000 and 7,000,000 radios were sold in 1953, including home radios, clock radios and portables. Of the total, approximately 25% were portables.

Although television experienced difficulty during the latter part of 1953, sales of the year were in the range of 7,000,000 units. Several manufacturers use injection molded masks and so-called "hi-hats" for protecting the end of the picture tube. Rubber modified compounds are specified.

With the advent of color, television is expected to enjoy a new "boom". Initially, colored sets will be priced at approximately three times the cost of black and white, but by 1957 it is expected this will be reduced to two times black and white.

Forecasts indicate that sales of black and white sets are expected to continue at the rate of 7,000,000 to 8,000,000 per year and sales of colored sets are predicted as growing to 3,000,000-3,500,000 within five years.

Injection-molded masks and "hi-hats" are meeting with strong competition from other materials and forming methods. Every effort should be made to preserve and expand this market for modified styrene, even though other techniques may cut in to some degree.

AUTOMOTIVE BATTERIES

The application of rubber-modified styrene in injection molded automotive battery cases is just getting under way. A styrene case weighs only half as much as the conventional asphalt composition or hard rubber case, and is superior in many ways. Inherent color possibilities add to merchandising value and color can be used to identify the product of a given manufacturer. The plus value of color is further emphasized when it is realized that approximately 75% of all batteries sold are for replacement, and women do most of the buying while friend husband is at work.

Although the styrene compound is more expensive per pound than either the asphalt composition or hard rubber, there are compensating factors. A more rapid molding cycle cuts down manufacturing costs and fewer sets of dies are required to obtain equal production; lighter weight results in important shipping economies; and superior performance permits higher selling prices.

There are approximately 25,000,000 automotive batteries sold annually. Roughly, 50% have asphalt composition type cases and 50% have hard rubber cases. Hard rubber is used for premium batteries and, at present price levels, we look for the adoption of injection molded rubber modified styrene cases for batteries carrying extended service guarantees, partially replacing hard rubber. Assuming we can capture approximately 25% of total sales, use of the styrene case in over 6,000,000 batteries annually will be our immediate goal. At approximately 3½ lbs. per case, this is a sizeable market. Long range, however, we have the full 25,000,000 battery-

Room air-circulator.

per-year market on which to direct our attention.

There are many more applications for injection molded rubber modified styrene in various fields. Several of these have already been explored to some degree but a tremendous potential market can be enjoyed if necessary effort is directed to this end. Included is a wide range of applications in the photographic field, signs and displays, packaging, pipe fittings, luggage, textile bobbins, furniture and eyeglass frames.

The designer of today considers a given product in relation to its cost, assembly and function. Recognizing the important contribution of plastic materials, he designs exclusively for plastics, and in rubber modified styrene for injection molding, we know we have a material which meets the demands of product designers. This is a new concept of design which is resulting in much larger markets for plastics.

It has been said that we are living in a dynamic economy where changes have been rapid and where the opportunities for further expansion in the next few years are so great as to almost stagger the imagination. The future presents a challenge to the entire plastics industry. If we take advantage of the opportunities we have to expand the markets for injection molded rubber modified styrene, industry sales of more than 300,000,000 lbs. will be a reality by 1960. This is a long way from liquor pourers, isn't it?

Air conditioner unit cabinet.

Present and Future Applications of Heat Resistant Modified Polystrene

by Charles J. Snyder
Koppers Company, Incorporated

Have you boiled your table model radio cabinet today?

Of course you haven't, but did you ever realize that a radio in operation often produces enough heat to bring about deformation of low heat distortion temperature plastic cases? How many times have plastic molded objects been seen which were twisted and deformed while on display in store windows exposed to the sun's rays? Furthermore, what happens to many plastic objects which are left standing on a hot radiator in a home or office? Distortion and deformation to the point where the object is often rendered useless, that is what happens.

Consequently, boiling a plastic radio cabinet might seem somewhat ludicrous; but, on the other hand, it might conceivably be an economical way to assure that a product will not be returned for replacement or credit because of deformation in storage or operation.

The boil test in which dimensional changes are noted in at least two major directions, length and width, has been found to be a fairly accurate indicator of the heat resistance of thermoplastic products. Using this test, material suppliers have been quite successful in suggesting the proper heat distortion type polystyrene for various applications when environmental and operating temperatures are known factors.

The history of the evolution and use of heat resistant polystyrene has been used in the development and promotion of the modified polystyrenes. It is easy to recall the numerous radio parts, wall tile, battery cases, housewares and numerous other items made from the low heat distortion temperature general purpose polystyrenes of the mid 1940's which frequently deformed under moderate heat conditions. Misapplications of this type gave plastics in general and polystyrene in particular a poor reputation in consumers' minds. Despite this situation, it wasn't until late 1948 that the higher heat distortion temperature polystyrenes were produced and sold at a low enough price to enable manufacturers to put heat stable products on the retail market. From that time forward, markets previously untouchable became prime targets.

This same story has its sequel in modified polystyrene. The first "high impact" types, which were general purpose grades, were available in 1949. These materials were very much like their polystyrene counterparts, that is, they easily deformed at continuous temperatures above 130°F. It was not until the fall of 1952 that higher heat distortion temperature "high impact" modified polystyrenes became commercially available. At the same time, higher heat distortion temperature "medium impact" polystyrenes were placed on the market. These developments are very significant since the availability of heat resistance in the tougher, more resilient modified polystyrene enables designers and manufacturers to overcome objections to products from polystyrene.

Before enumerating the various applications in which these materials are being used, it seems worthwhile to review some comparative properties of the heat resistant modified polystyrenes with their polystyrene counterparts and with each other.

Figure 1 shows the comparison of general purpose polystyrene with heat resistant polystyrene.

FIGURE 1
Regular Polystyrene

Property	Units	ASTM Test Method	General Purpose	Low Thermal Shrink
Specific Gravity		D792-48T	1.05	1.05
Tensile Strength	PSI	D638-49T	6500	9000
Elongation in Tension	%	D638-49T	1.5	1.5
Boil Shrinkage				
½ hour at 212°F				
Change in length	%		29	4
Change in width	%		14	1.5
Heat Distortion	°F	D648-45T	175	201

It will be noted from Figure 1 that although the density and general properties of both types of polystyrene are similar, there is a marked resistance to heat distortion in the low thermal shrink type.

A similar comparison between the "medium impact" modified polystyrenes is shown in Figure 2.

FIGURE 2

Medium Impact Modified Polystyrene

Property	Units	ASTM Test Method	General Purpose	Low Thermal Shrink
Specific Gravity		D792-48T	1.05	1.05
Tensile Strength	PSI	D638-49T	5500	6500
Elongation in Tension	%	D638-49T	12	12
Boil Shrinkage ½ hour at 212°F				
Change in length	%		25	9
Change in width	%		10	3.5
Heat Distortion Temp.	°F	D648-45T	175	195

Figure 2 shows that the elongation of the "medium impact" modified polystyrenes is about eight times that of regular polystyrene. This coupled with the fact that the physical strengths of these materials are not decreased to any significant degree demonstrates that products made from these will be tougher and more elastic, than similar ones made from regular polystyrene. There is some slight loss of thermal shrinkage resistance, but the main point to be noted is that the low thermal shrink "medium impact" modified polystyrenes undergo only ⅓ as much change in dimensions as the general purpose "medium impact" material when subjected to the same rigid boiling test.

FIGURE 3

High Impact Modified Polystyrene

Property	Units	ASTM Test Method	General Purpose	Low Thermal Shrink
Specific Gravity		D792-48T	1.05	1.05
Tensile Strength	PSI	D638-49T	4500	5000
Elongation in Tension	%	D638-49T	35	35
Boil Shrinkage ½ hour at 212°F				
Change in length	%		24	9.5
Change in width	%		10.8	4.3
Heat Distortion Temp.	°F	D648-45T	175	195

Pursuing the subject further, Figure 3 shows a similar comparison for the "high impact" modified polystyrenes.

In Figure 3 the elongation of the "high impact" modified polystyrene is about 23 times the elongation of regular polystyrene and almost three times that of "medium impact" modified polystyrene. In obtaining this tremendous increase in elongation and toughness, there is little loss in heat resistance. This is shown by the fact that the change in dimensions upon boiling is still only about ⅓ that of the general purpose "high impact" modified polystyrene.

From the foregoing data, it becomes obvious that low thermal shrinkage modified polystyrenes have as much a place in injection molded and extruded products as their predecessor low thermal shrinkage regular polystyrene has had. With this in mind, it is of interest to look at a few present day commercial applications for these materials and do some theorizing about where they could be used to improve future products.

At present practically all air conditioning fronts and grill inserts are made using "medium" or "high impact" modified polystyrene with the predominance in the medium category. Some manufacturers have already indicated a preference for the low thermal shrink types.

A trend is underway to convert radio cabinets from regular polystyrene to modified polystyrene. To obtain as high a gloss as possible and retain the maximum heat resistance the preference has been for the low thermal shrink "medium impact" modified polystyrene.

Acid and alkali storage battery cases, particularly for use in jet aircraft and automobiles, are now being made in production from both the "medium" and "high impact" type materials. Toughness and resistance to heat encountered in automobile operation have been the prime reasons for selecting these materials.

(please turn to page 50)

Dehumidifier Housing:—made from low thermal shrink high impact modified polystyrene.
(Courtesy: Admiral Corporation, Chicago, Illinois.)

Automobile Storage Battery Case—made from low thermal shrink medium impact modified polystyrene.
(Courtesy: Gould National Battery Company, St. Paul, Minnesota.)

AROUND THE WORLD

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AUSTRIA

OESTERREICHE
PLASTIC RUNDSCHAU

October, 1953

Abstracter: Herbert Meyer

POLYAMIDES FOR FABRICATION BY EXTRUSION, by Werner Stiner

An instructive treatment of the polyamides (nylon) which, due to their chemical composition and being of crystalline structure, exhibit properties quite apart from those of more conventional thermoplastic resins. These differences are discussed in detail relative to choice of fabricating conditions and engineering considerations when processing polyamides on extruders.

PLASTIC DISPERSIONS, by Konrad Quarthal

A general paper on the various methods of making plastic dispersions, the monomeric constituents employed, the properties and the principal commercial applications of plastic dispersions.

PROPERTIES AND USES OF RIGID POLYVINYL SHEETS, by Georg Niethaur

A description of the various improvements in mechanical properties obtainable with the recently developed process of post-treating rigid vinyl sheets. The original sheet material is oriented by stretching and allowed to partly shrink back under heat. This thermal post-treatment increases such properties as tensile, shear strength, flexing endurance, homogeneity, and correspondingly aroma and water vapor impermeability. An impressive summary of the many present and potential uses of rigid vinyl sheet material follows.

PLASTIC MATERIAL OF AUSTRIAN ORIGIN

A useful tabulation of plastic materials made in Austria listing generic chemical composition, trade name and application.

MACHINING OF AKULON FABRICATES

Akulon, European trade name of a nylon type plastic, presents problems in machining operations which are partly encountered with all thermoplastic materials. One specific difficulty is recognized in the relatively pronounced water sensitivity of polyamides which can cause dimensional fluctuations. The article describes, in detail, ways and means to cope with such problems in performing the various steps of machining operations on polyamide type materials.

UNSATURATED POLYESTER RESINS, by Roland Linke

The paper consists of a general treatment of the chemistry of polyester resin forming components, the process of making polyester resins and fabricates thereof, properties of end products and fields of application.

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BELGIUM

MATIERES PLASTIQUES
ET RESINES SYNTHETICS

No. 67, Nov.-Dec., 1953

Abstracter: Alfred P. Daignault

A NEW HERMETIC SEALING SYSTEM (Illustrated) F. Crigui (Page 17)

This article describes a method of hermetically sealing thermoplastic containers with emphasis on their usage in the food packaging industry. In this method the cap of the container which contains a rubber gasket is placed in a fixture which brings the cap close to the lip of the container. Sufficient space is allowed between the two to insert a knife blade. A series of electrically heated "soldering points" produces an actual fusion of material in the cap and container at equidistant intervals around the circumference.

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DENMARK

PLASTIC

Vol. 3, No. 9, Sept., 1953

Abstracter: Erik R. Nielsen

POLYVINYLCHLORIDE TUBING FOR SHRINK-FIT APPLICATIONS, 106-108.

PVC tubing (Kautex-Vietum, Kautex Werk, Germany), formulated to give 30% cross-sectional and 10-15% longitudinal shrinkage when heated to 100-120 C, is used as protective or decorative covering for pipe, wire rope, handles, etc. The method is applicable only to such forms which have no concave contours and to diameters between 3 and 60 mm.

Vol. 3, No. 10, Oct., 1953

POLYVINYLCHLORIDE FOIL ACCELERATES ROOT GROWTH, 113-116.

A description is given of the airwrap-film method for root propagation on cuttings from trees and plants (Agri-Plast Corp., Sarasota, Florida).

PLASTICS ON THE ROOF OF THE WORLD, 116-117.

The latest Mt. Everest expedition carried rations sealed under high vacuum in a pliofilm-cellophane laminate, according to the Vac Pac-process of E. S. & A. Robinson Ltd., Bristol, England.

Vol. 3, No. 11, Nov., 1953

PLASTISOLS. Bakelite Company, USA, 121-125.

General description of plastisols and their applications.

STYROPOR-FOAMPLASTIC. V. S. Badilin, 128-129

Styropor is polystyrene which contains a foaming agent of undisclosed composition, and is supplied in granular or block form.

The granules are foamed by immersing them in hot water (95°C) for 3 to 5 minutes. The dried foamed granules are charged to plate molds which are then heated by passing steam or hot water into the mold

Upon the action of heat, the granules soften or expand further, become plastic and fuse together. At the same time the condensed steam or the water is again expelled. By the steam method, plates are obtained in about 20 seconds which have a specific gravity of 0,025 and up, whereas by the hot water method the time is 4 to 10 minutes and the specific gravity 0,06 and up. When a higher specific gravity is desired, unexpanded granules are used, and the mold is only partly filled.

The block material is sliced to get 10 to 15 mm. thick plates which are immersed in hot water for 20 minutes. A 20-fold volume increase is obtained, and an additional 50% increase may be obtained by repeating the treatment after aging. This material is cut into ribbons which are used as high frequency insulation.

Vol. 3, No. 12, Dec., 1953

TEFLON. G. Mucha. 133-137

The manufacture, physical properties and applications of Teflon are reviewed.

FORMVAC—A machine for vacuum-deepdrawing and -forming. P. A. Sauter. 140-141.

Detailed description of a Swiss machine for deepdrawing and forming of plastics. The relatively high production speed is stressed.

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FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 6, No. 2, February, 1954

Abstracter: Hans Mayer

Description of method used in the production of a glass reinforced office chair base. (City Auto Stamping Co.)

Description of armored vests and body armor used by the U. S. armed forces in Korea. The glass reinforced type used by the Marine Corps and the nylon layer type used by the Army are both discussed.

PLASTICS AND CORROSION IN THE U.S.A.

The application of different types of plastic materials for the manufacture of pipes, tubings, ducts, acid containers and special fittings for the processing industry are discussed.

PROBLEMS OF COLORING PHENOLIC COMPOUNDS—A. Haehl and R. Thiollet

The coloring of phenolic compounds is a special problem because the resin itself has a yellow tint which is naturally accentuated by the natural color of the wood filler. The problem therefore is to find coloring matter which will blend with the compound, will not change under heat, and will not be affected by the resin itself. It is described how satisfactory results on a laboratory scale can be achieved by coloring part of the wood filler and introducing this colored portion into the final blend, having it act as a pigment for the balance of the mix. Since this method is not practical on a production scale, it is then discussed which of the following groups of organic coloring matter is suitable: water and resin solution resistant, soluble by resin, and soluble by water. The authors believe that the third group only will give suitable results. Inorganic coloring matters change the electrical properties of the plastic molding and are therefore not recommended where electrical properties are of importance.

CHECK RESISTANCE OF PLEXIGLASS WHICH HAS BEEN EXTENDED UNDER HEAT. H. Peukert

By extension the internal structure of Plexiglass is changed. The molecules arrange themselves in the direction of the extension and the mechanical properties of the material are changed. Tests and test results are discussed at length.

Report on the work of different committees of the International Organization on Standards for Plastics.

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GERMANY

DER PLASTVERARBEITER

Vol. 4, No. 10, October, 1953

Abstracter: Ernest C. Bernhardt

This issue presents only a general review of the plastic raw-material developments of 1953.

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KUNSTOFFEE

Vol. 44, No. 2, February, 1954

Abstracter: Anne Schwend

FARBENFABRIKEN BAYER AG. Leverkusen

This company announces a change in trade-names. From now on Polyurethan U will be designated "Durethan" U and the former Polyamid BK "Durethan" BK.

REDUCTION OF PLASTICS — by Dr. Hans Rumpf, Augsburg

Part one of this article considers particularly the physical process taking place in various, sometimes highly specialized granulators, disadvantages and desirable accompaniments and the progress that may be obtained by observing the physical process. Fracturing of plastic parts of homogeneous and inhomogeneous structure, the propagation of the breaking speed, energy conditions upon reduction of the individual grains, distribution of grains, reduction of the many different groups of plastics and the size of granules desired as well as applicable granulation methods are given a good survey. Part two of the article viewing the mechanical problems is to follow.

INVESTIGATION OF TEAR PHENOMENA IN PLASTICS, by Prof. Dr. Schardin

High frequency cinematographic shots were taken already some time ago of the the tearing of plastics at sudden intensive loading through the explosion of dynamite or the falling down of weights on the specimen. To follow up on these tests, Plexiglass plates were clamped into a tearing device and by means of a hydraulic cylinder were exposed to slowly increasing loads. The progress of tearing, the tension in the plastic material preceding the bursting, the receding of the material bordering the fracture line to original thickness and the propagation of elastic waves emanated by the fracture faces are made visible with the help of a multiple spark camera working with four lenses and registering 24 exposures on a photographic plate of 18 by 24 cm in size. The tear speed of Plexiglass was stated to be between 546 and 765 yds. sec. depending on the static load at the moment of completion of bursting. The tear speed at the beginning of bursting is about two thirds of the final speed. Duration of the initial speed depends on the speed with which the load increases. Forked fracture lines show that the tearing speed depends primarily on the elongation rather than on the tension in the specimen. However, in case the tension is reduced to a point that it will no longer yield the energy required for a continuation of the bursting, the tear speed will either slow down or the burst lines will get stuck. A series of snapshots demonstrates the ceding back of the tension energy after completion of bursting and the progressing of transversal waves. Micro- and macro-exposures show the quality of the fracture faces.

Investigations are under way to determine the speed of fracture with the help of transversal waves emitted by ultrasonic equipment in opposite direction to that of the burst line. This causes a periodic deviation of the fracture orientation. The speed may be determined by the ultrasonic frequency and the wavelengths shown by the fracture faces.

Finally, the tearing speed of cellulose acetate and polyethylene films are discussed. While the burst lines will branch off from the main line in circular form with normal films, the burst lines of pre-stretched films will expand at right angle to the stretching direction.

Fortsetzung

CONVENTION OF THE SWEDISH PLASTICS SOCIETY IN AUTUMN 1953

A brief on papers presented at the November Convention in Stockholm which partly already appeared in "Kunststoffe" and for the greater part will be published in this magazine shortly.

EXTRUSION OF POLYSTYRENE

Continuation of a series of articles, this time dealing with the proper design of dies, temperature control, take-off equipment and cooling means.

DESIGN OF INJECTION MOLDS, by Hans Gastrow

Various forms of fastening inserts and guide pins in injection molds are discussed.

CHLORINATED PARAFFINES, AROMATICS AND EXTENDERS USED AS PLASTICIZERS FOR VINYL POLYMERS, by Dr. Gerhard Beck

Discovery and development of vinyl polymers necessitated a systematic search for plasticizers of equal quality and life. Aside from certain hydrocarbons, chlorinated aromatic and aliphatic substances showed good compatibility with polyvinyl compounds and especially polyvinylchloride. The properties and applicability of such extenders and plasticizers are discussed. It was observed that PVC film with a high precentage of chlorinated paraffine or chlorinated diphenyl plus a small amount of gelatinizer showed no traces of migration when in touch with nitrocellulose, acrylates or vinyl acetates and polymers. To eliminate all migration tendencies chlorinated products, particularly chlorinated paraffines and the polymer Arochlor types may be blended with polyester plasticizers or phthalic acid esters of the dicyclohexylphthalate type.

Industrial application of these plasties is discussed. Processing methods: calendering and extrusion, difficulties to be overcome upon calendering of chlorinated paraffines, use of fillers and cover top layers to prevent darkening or changing of color in floor coverings which would be due to absorption of substances from rubber soles, and other points to be observed upon processing are briefed.

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HOLLAND

PLASTICA

Vol. 6, No. 3, March, 1953

Abstracter: W. P. ter Horst

POLYAMIDES: AKU, Arnhem, pp. 124-129

Caprolactam fiber, Enkalon, and caprolactam plastic, Akulon are manufactured at Emmen. The purity of the monomeric caprolactam is of utmost importance.

Polymerization is carried out at about 250°C. in the presence of a catalyst; depending upon the degree of polymerization various types of polymers are produced.

Outstanding properties of the polyamides-plastics are: High wear resistance, good friction resistance, good sound dampening, corrosion resistant, not affected by molds or bacteria, boil resistant, easily fabricated, tough even at low temperature, excellent fatigue resistance, resistance to distortion at 100°C., great tensile strength.

Amongst the applications are: Parts for textile machinery, rollers, bearings and cable jackets.

Vol. 6, No. 4, April, 1953

"PHORYL" RESINS: R. Tunteler, pp. 156-157

Phoryl-resins are linear aromatic phosphates.

These thermoplastic resins have been developed by I. C. I. in England.

Phenols are reacted with phosphoroxychloride to yield aryloxphosphoryldichloride which is then further reacted with an aromatic dihydroxy compound, for example hydroquinone. The polymers thus obtained are clear, practically colorless resins, molecular weight about 15,000.

Applications: Lacquers and adhesives.

THE VISCOSITY OF MACROMOLECULAR SYSTEMS: Report on Lecture by A. Peterlin, pp. 168

The viscous flow properties of molten polymers and concentrated solutions and of dilute solutions were discussed, while polyelectrolytes were not included. The factors influencing the viscosity: temperature, pressure, shear rate and molecular weight were considered. Mechanisms of flow in these systems are treated in some details.

Vol. 6, No. 10, October, 1953

REINFORCED PLASTICS: W. H. Brinkman, pp. 436-440

In this article the polyester-glassfiber materials are discussed. Attention is paid to the preparation of the polyester-resins, the treatment of the glassfiber in order to get better adhesion, the properties of the laminates, the most important molding methods and finally the different applications of this new material.

Vol. 6, No. 11, November, 1953

REACTIVE INTERMEDIARY PRODUCTS OF POLYMERIZATION REACTIONS: G. Salmon, pp. 506-508

The role played by labile intermediary products, radicals and carbonium-ions, is elucidated, starting with very simple chemical reactions and proceeding to more complicated ones such as polymerization reactions.

The complexity of ionic reactions due to the interaction of the labile intermediary product and the solvent is stressed.

POLYESTER GLASSFIBER PRODUCTS: R. J. Schliekelman, pp. 484-487

In this article the polyester-glass fiber materials are discussed from the constructor's point of view. The design has to be adapted to the properties of this new, promising material of construction. Successively discussed are the requirements, which the specification of the product to be made must meet, the choice and study of the material and the factors which must be taken into account when using polyester-glassfiber material as a substitute for a wooden or metal construction.

Vol. 6, No. 12, December, 1953

THE EXTRUSION OF THERMOPLASTICS: E. A. J. Mol, pp. 536-541

In this article which appears in different issues of Plastica the main subject, i.e. the theory of the screw in connection with the rheology of the materials to be extruded is discussed. It shows that shape and dimensions of the screw are closely related to the rheological behavior of the thermoplastics as well as to the dimensions of the products to be extruded.

Vol. 7, No. 1, January, 1954

THE PERMANENCE OF POLYETHILYENE: Anonymous, pp. 20-22

Polyethylene is susceptible to thermal oxydation, sunlight oxydation and "stress-corrosion" (cracking). Antioxidants retard thermal oxidation, carbon black minimizes. The effect of ultra violet light; the best means to prevent cracking is by not exceeding the limit of elasticity which is 4 to 4½% on deformation.

CORRELATION BETWEEN DYNAMIC EQUILIBRIA AND CHEMORELAXATION: G. Salomon, pp. 30-32

The curious phenomenon of dynamic equilibria and the existence of ceiling or floor temperatures for the formation of polymers are discussed and correlated with chemorelaxation processes. The importance of this correlation for fiber technology is briefly indicated.

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ITALY

MATERIE PLASTICHE

Vol. 20, No. 1, January, 1954

Abstracter: Alfred L. Alk

RE-ENFORCED PLASTICS FROM GLASS CLOTH AND RESIN A

LOW PRESSURE: J. Duflos

Continuation of a series of articles dealing with low-pressure laminates. This section deals with strength characteristics of glass fibers; various types of glass cloth; physical properties of laminates made with phenolic, polyester, epoxy and other resins. The article describes the various surface treatments given to glass fibers for plastic uses. Illustrated with photographs, cuts, tables and charts.

INJECTION MOLDING OF THERMOPLASTIC RESINS: M. Sirtoli

Continuation of a series on various designs of injection molds. This article describes:

a. Molds with valve-like pins in the core.

b. Multiple molds with auxiliary gating.

c. Multiple molds with a device for cutting sprues.

d. Multiple molds with capillary injection.

e. Molds with devices for unscrewing by means of conical gears.

f. Molds with devices for unscrewing by means of a toothed crown.

g. Molds with devices for unscrewing by means of transmission gears.

h. Molds with devices for unscrewing by means of rack gears.

Each mold type is illustrated by one or more line drawings with labeled parts, and the text explains the operation in detail.

NEW DEVELOPMENTS IN POLYMERIZATION: E. Cernia

Recent developments, particularly U. S., are discussed. Detergents, emulsifiers, anti-static agents and adhesives are presented as examples of molecules built for specific applications.

POLYETHYLENE FOR WATERPROOFING FLAT ROOFS AND TERRACES: G. Guzzetta, pp. 9-13

Sheets of Polyethylene have withstood twelve years of service as moisture barriers in roofs. The unfinished roof is coated with a smooth paste composed of 54 parts Polyvinyl Acetate, 43 parts Kaolin and 3 parts Iron Oxide. Polyethylene film 0.006 inches thick is then laid on and each length is heatsealed to its neighbor between strips of kraft paper by means of a flatiron. At least one inch of concrete is applied on top of the Polyethylene to prevent solar degradation. The PVA paste is used to fill all joints since the usual bitumins soften the Polyethylene. Comparative costs are discussed between this and more common procedures.

PLASTICS AND MODERN ARCHITECTURE: G. Ponti

Summary of architectural uses of natural materials; their replacement by plastics; and the advantages of plastics in modern design.

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SWEDEN

SWEDISH PLASTICS FED. TECHNICAL BULLETINS

Abstracter: Walter E. Werber

Volume VII, Nr. 45, December 1952

REINFORCED LOW PRESSURE PLASTICS AND THEIR USE FOR CONSTRUCTION MATERIAL, by Ingenieur Bjoern Wennerholm, AB Volamin, Sweden.

The author discusses the steady growth of these materials after the war and notes its superiority over many of the conventional materials. Particular attention is paid to the glass reinforced polyester type material, which have become so popular in the U.S.A. The author defines the process of low pressure molding and describes briefly the different methods currently employed.

Volume VIII, Nr. 1, January 1953

FABRICATING METHODS FOR ACRYLICS, by Civ. Ing. Holger von Fieandt, AB Bofors Nobelkrut, Sweden

Machining of acrylic sheets material is discussed in great detail and special consideration is given to cutting and drilling. Polishing is mentioned specifically with the new gas methods as compared with the older mechanical ones. Vacuum forming and all methods of cementing are discussed prominently and directions are given for the upkeep and cleaning of acrylic glass.

Volume VIII, Nr. 2, January 1953

STABILIZATION OF PVC. Some points on their developments and practical applications, by George W. Elliot, Associated Lead manufactures Ltd. England.

The article covers a wide range of stabilizers, such as stearates, lead phosphate, lead silicates, and describes its effects on PVC mix in detail. A brief description is given in the beginning as to the need for stabilizer and the effect of different amounts and types in relation to the type of polymer and plasticizer used.

Volume VIII, Nr. 5, February 1953

EXTRUSION OF NYLON (Grilon) and other working methods for Polyamids, by W. Stiner, Holzverzuckerungs A. G. Zuerich, Switzerland

The author discusses in great detail the specific requirements of Extrusion equipment for the use of Polyamids, requirements necessary because of the inherent qualities of the Polyamids. A thorough analysis is given of the properties of Grilon in physical and chemical respects. The author has illustrated cylinder construction for Injection molding as well as extrusion screws and has succeeded in giving valuable information regarding the technique for both molding and extrusion of Grilon.

Volume VIII, No. 9, March 1953

DEFORMATION CHARACTERISTICS OF PLASTICIZED P. V. C. AND ITS PRACTICAL IMPORTANCE, by A. Hill, B.Sc. Tech. The Geigy Comp. Ltd. Manchester

The deformation behaviour of plasticized PVC recorded in the form of modulus of rigidity, standard hardness of 100% is tested under exposure tests of different duration. Compounds having deformation characteristics which are not time dependent are suitable for curtain materials etc., others appear much stiffer exhibiting leather like appearance. Torsion tests of different types and at various temperatures are described and the author emphasizes the need for a more rapid and less elaborate method to attain the deformation results.

Volume VIII, Nr. 10, March 1953

ELEMENTS OF KNOCKOUT MECHANISM ON MOLDS, by Kurt Brandenburger

The author discusses and illustrates in great detail various types of ejector mechanism for plastic molds. Of great interest to tool-designers and moldmakers.

Volume VIII, No. 13, April 1953

PENOL RESIN GLUES FOR PLYWOOD, by H. A. Collinson, F.R.I.C. Technical Director, Leicester Lovell & Co. Ltd. England

First results of the five year test of the British Forest Products Research Lab. after exposure to the British climate are discussed and conclusions are drawn. Amongst those the statement is made that only the plywood made with phenol or resorcinol glues shows no sign of breakdown.

Volume VIII, No. 14, April 1953

THE COOLING OF INJECTION MOLDS, by Heinrich Spies

Various methods of cooling of injection molds by means of air and water are discussed together with drawings to illustrate these methods.

Volume VIII, No. 15, April 1953

THE JOINING OF DIFFERENT MATERIALS BY MEANS OF ARALDITE RESINS, by Dr. Ing. Chem. Konrad Meyerhans, Ciba A/G Basel, Switzerland

The author describes in detail the Ciba epoxy resins, Reg. trade mark Araldite resins as bonding agents and cast resins its properties and the methods used to join various materials. A number of comprehensive charts are used to describe the properties of these remarkable resins in great detail.

Forthcoming

THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

SLAPPED—(DERATING DOES IT)

It's getting so every time injection molding breaks into the national press, we get a slap in the face. I quote from the Wall Street Journal, February 4, 1953, p. 20:—

"The do-it-yourself trend — has given (the plastic wall tile) business a push in the last year. Poor quality of wall tile made by a few manufacturers was one factor in holding sales back."

At the root of our unfavorable publicity one sees only one thing — derating. In other words if 6 instead of 8 cavities were used, if a 30 instead of a 19 second cycle were used, and if we got away from the idea of speed records and laid the emphasis on quality, the whole industry would be bettey off. This business of trying to stretch an injection machine's REAL or SAFE ability to melt plastic without degrading it is going to be the ruination of us yet.

SLAPPED AGAIN!

Fortune Magazine in the February issue, 1954, covers the polyethylene picture pretty thoroughly. The writer of the article pulled no punches. He said in part:

"The seriousness of the quality problem is aggravated by the fact that polyethylene, being a plastic, will reach the public only through the hands of the plastic processors — injection molders — who have historically been infested and undermined by fly-by-nights and quick dollar operators. Until now, polyethylene has escaped most of the shoddy merchandizing that other plastics have suffered (e.g.—excessively fragile styrene toys). But this immunity has been the result of short supply and careful allocation by the two sole producers."

He then mentions how a soured public could ruin polyethylene's prospects.

We have found that heating cylinders can be modified to give improved performance on polyethylene. Ratings must be carefully figured, cylinder heats closely regulated and mold heats scientifically controlled.

Over-rating of presses by ambitious and competitive - minded machinery people and speed-record conscious molders is a real curse and can bring the dour Fortune prediction true, what with warped containers, mixing bowls that peel, lids that won't fit, etc., etc. Correct heating cylinder design is the chief answer—but outside of our own feeble efforts to build a heater specifically for polyethylene, I don't see any other concerns talking up special purpose cylinders. They're just socking the heat to standard ones and letting the molder struggle through, and before the situation is ironed out on press ratings, chances are some mighty poor polyethylene parts may hit the market. Too bad all around, but I guess it is humiliating to admit just what the facts of derating really are, especially in competitive periods like this.

HOMEMADE—DERATING

Two comments made in this column that considerable savings can be made by building your own injection machine, and that the new styrene copolymers require extra-capacity cylinders to bring the machine to its rated output caused quite a stir in the trade. Evidence continues to accumulate to prove I was right on both points. I have just seen another excellent home-made press that would cost over $30,000 commercially. It cost about $15,000 to build, and what with writing off direct labor, went on the books at about half that! And those molders who wonder why their high impacts are brittle and off-color, and who are installing oversize heaters to melt the material safely continue to prove my point: to put out quality moldings you should re-figure your press capacity in the light of its ability to handle a given plastic. Bakelite's excellent C-11 which I mentioned specifically, continues to expand the field of application of thermoplastics, and molders continue to tell me that somewhat longer cycles and lower heats give better results with all modified co-polymers. Much of the furor about such a simple fact was raised because a leading paper was scooped by the SPE Journal, and because my remarks were quoted out of context. Just like the furor about wire tapping. Few people realize how you can doctor a tape recording by snipping and patching to make a person say something entirely different and the same thing happened here. It's extremely heartening to run into case after case that proves my theories though. And my first two headings this month — "Slapped" and "Slapped Again," seem to prove I was on the right track. Remember, a prophet is not without honor, etc.

Decorating of Plastics Is Topic at Toledo

R. E. Dunham

A unique talk on "Marking and Decorating of Plastics" was presented by Mr. Arthur Skeels of Art Roll Leaf Stamping and Art Marking Specialists at the regular meeting of the Toledo Section on February 24, 1954. The talk was given at Harrison's Ranch House following an excellent dinner. Mr. Skeels outlined all forms of marking and decorating, yet at the same time gave specific facts concerning methods of decorating.

Hot leaf stamping, silk screen printing, offset printing, filling in of recessed printing, and spraying with masks were discussed in detail. Labeling, rubber stamping and application of decals were mentioned briefly.

The advantages and disadvantages of each method were carefully presented. Hot leaf stamping was indicated as cheap, fast, and easy. Although silk screen printing has advantages over hot leaf stamping, it generally presents more problems. Offset printing is used to secure fine detail and multicolor operation. Spraying can be used to secure high rate of application, but fuzzy edges present a disadvantage.

Interest of the 29 members and guests was evidenced by the lengthy question and answer period following the talk. Samples of decorated items were carefully examined by those present. The technical aspects of the meeting resulted in a wealth of information for all who attended.

Retiring President, Dave Cordier presented the gavel to the new President, W. R. Anderson. Other officers are H. W. Pioch, Vice President; W. G. Skutch, Jr., Secretary; D. R. Bowlin, Treasurer. Mr. Bowlin is also the new National Director. Mr. Anderson announced the following Committee Chairmen:

Professional Activities — Lee Lanfare; Membership—V. E. Hofman; Credentials—Elmer Faber; Program—Frank Rosenberger; House — K. L. McGill; Publicity—A. J. Gogel; Educational—J. C. Purdue; SPE Journal Reporter—R. E. Dunham; Electron Inspector—J. L. Bernard; Finance—Rudy Hartkopf; Auditing—G. R. Bennett; Nominating—Robert DeBrock; Historical—H. W. Pioch.

SECTION NEWS

Edited by
Stanley Bindman

Jamison Plastic Corp.
71 E. Sunrise Highway
Freeport, New York

New York Takes First Plant Trip to Monsanto; Plastic Tooling and Post-Forming Also Discussed

A. M. Merrill

The New York Section had two important activities during March: a plant trip, the first in its history, on March 10 to visit Monsanto Chemical Co.'s plastics division at Springfield, Mass.; and a regular dinner meeting on March 17.

More than 30 members took part in the plant visit, all arrangements for which were handled by Monsanto including a private parlor car for the round trip, a luncheon at Ravelli's Restaurant in Springfield, and a box supper on the train during the return trip. Upon arrival at the plant, the members heard talks by R. E. Hamer on Lustrex Hi-Test 88 styrene copolymer; R. F. Hill on Opalon vinyl resins and compounds; and E. S. Childs, Jr., on polyethylene resins and products. There was also a showing of the color-sound film, "Kitchencering," with commentary by W. F. Mueschke, illustrating the possibilities of plastics in kitchen design. Following the talks and film were tours of the research laboratories, cellulose nitrate sheeting plant, and the vinyl film plant.

Four members of the Monsanto sales staff, headed by Richard M. Thews, acted as hosts to the visitors during the trip. Dick Thews is a director of the New York Section, and a feature at the luncheon was the surprise presentation to him of a gift by the members in token of his services to the Section in the past, and as a present for his transfer to Springfield where he will be assistant director of sales for styrene.

The regular dinner meeting on March 17 in the Gotham Hotel was attended by some 85 members and guests and featured talks on "Plastic Tooling for Industry" by Dale Knepp, Kent Plastic Products, Inc., and "Post Forming Laminates for Industry" by Lewis A. Strottman, Formica Co.

Mr. Knepp's talk consisted of comments on a series of slides showing applications of phenolic casting and foam resins, and polyester and epoxy casting and laminating resins in industrial tooling, particularly for the automotive and aircraft industries. These applications include dies, die spotting fixtures, patterns, models, core boxes, duplicating and other fixtures, vacuum forming molds, and sample parts.

Mr. Strottman described the technique of post forming Formica laminate sheets now available in grades designed for such applications. The heating operation, which should be performed with infra-red lamps, is the critical factor in forming. The optimum forming temperature is 165° C. and the range is quite narrow; lower temperatures cause cracking of the sheets, while temperatures of 175-180° C. cause blistering. Forming should be complete within 10-15 seconds after the material has been removed from the heating position. The importance of forming die design was also emphasized by the speaker, who noted that the dies may be hardwood, metal or plastics, depending on the complexity of the final product. Illustrating the talk was a demonstration of a simple right-angle forming operation conducted by Stanley Zelwack.

Section secretary-treasurer G. Palmer Humphrey, R.C. Molding, Inc., presided over the meeting in the absence of the president and vice-president. Reports from the various committee chairmen and from the national director were heard in a brief business session preceding the talks. Table favors and door prizes were distributed through the courtesy of Pressman Toy Corp., and the prize winners were John Franzesi, Republic Aviation Corp., and George Gould, Plastic Materials Co.

Five new members were added by the Section during March, as follows: Irving Brecher, vice-president, Baby World Co., Inc.; Foster Monaco, president, Mastercraft Plastics Co., Inc.; William B. Plisco, owner, Wm. B. Plisco Co.; Leonard Schiff, purchasing agent, Caldwell Products, Inc.; and Howard W. Woodham, research engineer, National Petro Chemicals Corp.

Cellular Polyethylene Is Described for Quebec Section

Ian MacLaine

A meeting of the Quebec Section of S. P. E. was held in the Queen's Hotel, Montreal, on February 24th at 7:00 P.M.

The guest speaker was Arthur A. Allan of Bakelite Corporation (Canada) who presented a paper describing the new cellular polyethylene development of the Union Carbide and Carbon Laboratories.

Mr. Allan is an executive member of the Quebec Section of S. P. E. and a graduate of the University of Toronto in Chemical Engineering.

Mr. Allan clearly described the good mechanical properties, low moisture absorption, high resistivity and low power loss characteristics of Bakelite cellular polyethylene. The outstanding stability of these characteristics were indicated by several graphical relationships. The correct extrusion conditions were shown to be all important in fixing the desired specific gravity and dielectric constant as well as the ultimate cross sectional area of the extruded product. Complete conversion of the chemical blowing agent was shown to produce a specific gravity of 0.47 and a dielectric constant between 2.3 for the polyethylene and 1.0 for the inert gas.

Afterwards, Mr. Allan answered many questions that indicated the interest and appreciation of the membership for the subject matter and fine presentation.

SET SAIL FOR ATLANTIC CITY

European Plastics Industry and ISO Activities Described for Cleveland-Akron by Wohlford

Frank A. Martin

The Cleveland-Akron Section met on March 8 at the Spanish Tavern at Brecksville to hear a talk on "The European Plastics Industry" by Mr. Jack Wohlford, Manager of Sales Development for the Koppers Company.

Mr. Wohlford reported on the activities of the ISO Committee T-61 of which he is a member. This committee is working to establish international standard tests and specifications to eliminate the present confusion, and to make sure that everyone is talking the same language as it were. The work of this committee is of necessity going to be slow, but some progress has already been made. Six draft proposals have been approved, covering the following tests: water absorption, apparent density of molding powders, acetone solubles, flexural strength, and temperature of deflection under load. The work of this committee should be of great value to the world-wide industry.

Mr. Wohlford also gave us his impressions of the European plastics industry. To those of us familiar with our industry in the United States, the European situation was very surprising. For example, in France, one of the European leaders, the per capita consumption of polystyrene is 1/5 lbs. as compared to our 2 lbs. In Europe all runs are for small quantities, and it is not uncommon to change molds two or three times in one day. Injection machines are of much smaller capacity, and a 16 oz. machine is considered a large machine. International tariff barriers also tend to hold down the volume for injection molders. The European molders have a great respect for American "know-how" and in a few instances, have imported American talent.

Mr. Wohlford concluded that we need not fear competition from European molded goods, but that the material manufacturers are going to make a determined bid for American business.

Personals

The Section is sorry to say goodby to Vic Blatter. Vic is leaving his post as Sales Manager of Plastics Machinery for Akron Rubber Machinery Company after 12 years with that company. He is joining Rubber's Tool and Die of Elkhart, Indiana as General Manager. The whole section joins in wishing Vic the best of luck in his new venture.

Northwestern Pennsylvania News Notes

Paul C. Roche

Reports over the last several months have covered the new plastics business situations in the Northwestern Pennsylvania area, to the complete exclusion of personal items. Therefore we will catch up on what will be to some a lot of "old news."

Fred J. Kraft has for the past several months been associated with Quinn-Berry Corporation in charge of tool engineering. His immediate previous capacity was in engineering activity with Perry Plastics Incorporated.

Arnold Varnor, formerly of the plastics laboratory at the Erie Works of General Electric Company, has recently been transferred to General Electrics new "APPLIANCE PARK" at Louisville, Kentucky and is identified with the plastics production plant there.

Leo Schmelzer is now connected with N.B.C. Plastics Division, Nubone Corset Company, in charge of the molding room. Mr. Smelzer was formerly associated with Perry Plastics Incorporated.

After a long plastics career in the Erie area commencing with Erie Resistor Corporation, Chet Berry has recently taken up connection in Detroit with Process Mold Company.

One of the most recent machine tools added to the capital of Byrd Tool and Mold Company (and or Byrd Plastics Corporation) is one with wings and a propeller. One of these days we are going to find out from Bill Byrd whether the Sunday flights are business trips for Byrd Tool or Byrd Plastics.

Mr. C. J. Denmark has retired from active participation in the management of Presque Isle Plastics Incorporated because of illness. "Denny" is very well known in the area after his many successful years in business.

Kenny Erwin is now a Quality Control Engineer at Erie Works, General Electric Company. During his several years of membership in the Society of Plastics Engineers Mr. Erwin has been associated with the plastics laboratory at General Electric Company, has acted in an administrative engineering capacity, and has been on active duty with the United States Army.

Don Blair has had an advancement in position by Koppers Company. Formerly sales representative for the home office area, Don is now in an advisory and promotional capacity for specialized applications of thermoplastic materials. Don is really a digger.

Shaw Engineering Company of Franklin, Pennsylvania has recently made an addition to their capacity which will be welcome to the larger molders in the area. They have added their second Keller, thereby increasing in a major way their capacity to handle large injection molds and molds for production of fiberglas reinforced polyester materials. George Shaw and John Reib are active SPE members from that Company.

This may not sound very interesting on a hot day in early summer when this item completes the cycle and appears in the SPE Journal, but Harry Farnstrom (Farnstrom & Son) is in Florida for a month. On the strength of the Erie climate as of this writing I'd like to be there with him.

St. Louis Sees Savage Build Marco Boat

R. S. McDorman

On February 22, Mr. Dick Savage of The Celanese Corporation of America, Plastics Division, Marco Products Dept., gave a very interesting talk and demonstration to the St. Louis Section.

Mr. Savage discussed the Marco polyester resins from the chemical composition to the production techniques and methods of lamination. During the first part of his talk, Mr. Savage started the process to make a forty two inch boat by the Marco method. When his talk was completed, the boat molds were opened and a cured boat was presented.

Approximately one hundred and ten members and their guests attended the meeting.

Plastic Spray Masks, Stencils, And Holding Fixtures

A plastic putty for making reusable spray masks, stencils, and cementing fixtures for toys, signs, fire alarm boxes, and general industrial equipment has just been developed by the Chemical Development Corporation, of Danvers, Massachusetts.

Called CD SPRAY MASK A, it is supplied as a putty that will harden to an extremely strong, tough and rigid solid 1-2 hours after the addition of a catalyst or hardening agent. No heat or pressure is required.

Plastic Embedments As A Hobby and Polyester Fiberglas Molding At Western New England

C. W. Petersen

Over one hundred members and guests of the Western New England Section of the Society of Plastics Engineers were treated to an unusual demonstration of modern boat-making at the monthly dinner meeting in the main dining room of the Bradley Field Air Terminal.

Richard Savage, Director of Product Application, Marco Products Department, Celanese Corporation of America, was the main speaker and conducted an actual boat molding operation by the Marco method for forming large reinforced polyester parts. The process consisted of impregnating a Fiberglas mat lay-up with a polyester resin between molds under vacuum pressure and then allowing the material to cool and harden. The result was a small tough dinghy type boat hull which was presented as one of the door prizes.

The Marco method for polyester molding is now being used for producing radomes, shelters, sleds and boat hulls up to 37 feet in length.

FEBRUARY MEETING

The Western New England Section heard Mr. Ralph Mondano talk on "Plastics Embedments as a Hobby" at the Feb. 18th meeting. He urged that parents bring some of these interesting hobbies into the home and interest the youngsters in them. For his topic he two most important plastics are acrylics and polyesters and he spent most of his talk on the polyesters.

For his work he uses a silicon type mold release agent and finds that his prepel technique helps reduce shrinkage to a small three or four percent. Air entrapment is a problem and must be carefully handled and in some work he resorts to the use of vacuum pumps. He displayed many fine specimens of flowers, leaves, shell fish and other objects. It was pointed out that specimens must be prepared by coating to prevent discoloration during the curing cycle.

Our other speaker was Mr. Ernest E. Morenon of the Fenway Studios, and the Boston Museum and he discussed "Plastics in the Arts." He gave a short history on sculptoring and the various materials used for model making. Along with this, he presented colored slides which presented many of his works in marble. There are many steps to making a plaster of paris model and to getting it done correctly. Many times it must be discarded and started over again without any way to rework the model once it is cured or even before it is cured. Several plastics were tried, but the plastigels are most helpful to the artist because he can work his model until he has it to his liking and then it can be cured. Along with this, he showed several works of art which were done with acrylics.

It was a most enjoyable evening and took us out of the realm of industrial applications and into a field which was foreign to many of us.

Reinforced Plastics As Construction Materials For Jet Engines Is Topic At Miami Valley

Martin Kasch

The March meeting was held March 4th at Shullers Restaurant, Cincinnati. An attendance of forty (40) heard an interesting talk on "Reinforced Plastics as Construction Materials for Jet Engines," which was kicked off with a Walt Disney animated movie on "How and Why a Jet Engine Works." Slides were used during the talk showing comparisons between plastics and metals in weight, flexural strength under various conditions, etc.

The meeting was opened by Carl Ackerman, Vice President in the absence of Frank Strobino, Section President. Dick Rice wins again. His number was drawn for the free dinner.

The questions for open discussion were:

1. What is your experience as to the best choice of mold and die steel from the standpoint of polish, rust prevention, and minimum heat treat distortion? (Particularly for Polystyrene molds.)

2. What is best method of flash removal from threads and faces of inserts? What are relative merits of silver plating inserts before or after molding?

Dates and topics for future meetings were announced as follows:

May 6th — Eaton Manor, Hamilton. "Quality Control" by Prof. R. M. Lollar of Tanning Research Department of Applied Science, University of Cincinnati and Chairman, American Society of Quality Control Engineers.

June 4th — Terrace Park Country Club, Terrace Park, Ohio. Annual Golf and Picnic Meeting.

Guests were introduced as follows: Bill Berliner, Bob Whitehead, and Bob Cushman of G. E. Cincinnati; Bill Evans, of Kurz-Kasch, Dayton; Don Suer, of Plastic Moldings, Cincinnati; John Reimueller, of Buckeye Molding, Miamisburg; and Chas Dearth, of Dimco-Gray, Dayton.

FEBRUARY MEETING

The February meeting was held February 11th at The Wishing Well in Centerville, Ohio.

A record attendance of seventy-eight (78) members and guests heard Mr. I. B. Polhemus of Owens-Corning-Fiberglass Corporation talk on "Fiberglass-Filled Molding Compounds."

After the dinner session Frank Strobino, Section President, opened the meeting and introduced the guests and speaker.

Walter Oelman gave a report on the national meeting in Toronto.

During the discussion period following the main event, the Chevrolet "Corvette" sports car which was on display was discussed.

Byron Nelson gave a report on the assembly of the Corvette as he saw it on the assembly line in St. Louis.

Teflon Molding and History—R. I. & S. E. Mass.

Stephen Kalarian

The Rhode Island and Southeastern Massachusetts Section presented as guest speaker for its February meeting, Mr. Wilton A. Hawkins from the Field Service Laboratory of the Du Pont Company. A snapshot picture of Mr. Hawkins' background shows that he is a graduate of the Carnegie Institute of Technology and has been with Du Pont for the past five years.

Mr. Hawkins started his talk with a brief background on the history of "Teflon," giving 1940 as its birthyear for commercial production. With the aid of numerous slides, the techniques used in the fabrication of "Teflon" were presented. These included molding, screw extrusion, ram extrusion, calendering, and dip-coating. Molding covered the step process of preforming, sintering, and final coining operation. In coating wire with this material, production has reached the 20 ft. per min. rates. Other interesting facts were also revealed about the other processes. Because of special applications of this material, new inert fillers such as graphite, asbestos, talc, and coke-flour is entering the picture. The end uses of "Teflon" include packings, bearings, coaxial cables, resistors, and valve diaphrams. Mr. Hawkins concluded his talk with an optimistic view for further development of "Teflon" in industrial applications.

Prior to departure a dozen door prizes of miniature automobile extension lights were distributed through the Wiring Device Division of General Electric Company.

Training of Plastics Engineers Is Critical Problem for Plastics Industry—Upper Midwest

Jerome Formo

At the Upper Midwest Section meeting, March 15, 1954, Dr. Fulton Holtby, Associate Professor of Mechanical Engineering at the University of Minnesota spoke on the education of the plastics engineer. To indicate the nature of the problem which is confronting the plastics industry today as a result of the very rapid growth in the industry, Dr. Holtby cited the following figures:

In 1930, 20 million dollars was the gross value of the plastics industry. In 1935 it had risen to 90 million. In 1940 it was 180 million dollars and in 1950, 800 million dollars was the gross value of plastics. It is estimated that by 1975 this gross value will rise to somewhere between 8 and 20 billions of dollars. Thus the plastics industry is a growth industry and also a scientific industry, that is one which needs engineers in large quantities. Production equipment is becoming more complex with the addition of complicated hydraulic systems, electronic devices, the study of thermal dynamics, heat treatment of steel, etc. Newer molding material needs scientific evaluation for proper use.

Both plastic societies have education committees hard at work preparing programs for schools throughout the country. The present trend in engineering schools is not very encouraging for those of us in the plastics industry. First the change in educational policy now features more work in the humanities and common basic courses. And secondly, the cost of plastic laboratory courses is high which discourages schools from offering it in their curriculum unless a large number of students are interested in it.

In addition, Dr. Holtby indicated that in general students entering the university in these days do not have the benefit of plant experience gained in childhood as was common in earlier days to help them to plan their engineering courses. Now all engineering students take two years of identical courses before branching out in the specialties with the requirements for plastics engineering. It is extremely unlikely that an engineering student will get much useful information until he has reached the graduate school level. The problem of supplying engineers for furthering of the plastics industry is one which has a solution. Dr. Holtby suggested the following:

The plastics industry as such can take on a training program for new employees in it. In addition night schools around the country can offer courses in plastics with the cooperation of the local plastics industries. In the universities, Dr. Holtby suggested that the plastics industry could help by posting names of plastic companies on the school bulletin boards whenever openings exist in these companies for plastics engineers. Encourage plant trips. Organize trips of high school students, boy scouts, etc. Use the cooperative training program in which an engineering student works in an industry every other quarter. Set up scholarships for the industry.

In the case of American Foundrymen Foundation, one percent of the payroll of each company is suggested as its contributiton to this foundation. In seven years the American Foundrymen Foundation has reached scholarships of $107,000. Another means of encouraging students is to offer special rates for dinners at the meetings in the society. For example a one dollar dinner would be of interest to many college students whereas the normal price of a dinner for an SPE meeting is several times that.

A question and answer period followed Dr. Holtby's talk which indicated that a large number of those in attendance were particularly concerned with the problem that exists today and even more concerned with the problem of the future if the growth of the plastics industry is to continue at the indicated rate.

Structural Laminates In Helicopters Is Topic At Buffalo Meeting

R. W. Miller

Members of the Buffalo Section and visitors gained insight into structural laminates, February 19th, when Norm Wahl of the Cornell Aeronautical Laboratory discussed helicopter rotor blade construction from polyester resin and fiberglass cloth. Norm, a founder of the Buffalo Section, explained techniques and problems encountered when the Cornell Laboratory built blades from balsa wood, resin and glass cloth. A short movie showing the actual construction was also shown. Our January meeting was held in conjunction with the banquet at the Tenth Annual Technical Conference in Toronto. Several members and wives attended in addition to those members who attended the conference. New officers elected are Elmer Howard, of The Carborundum Company, President, Paul Bronnenkant of Sterling Molders, Vice President, Ed Leone of Curbell Inc., Treasurer, and Art Scutt of The Carborundum Company, Secretary. Elected directors to the nine man board are Messrs. Healey, Veverit, Howard, Bronnenkant, Glass, Engl, Van Geem, Roeck and Scutt.

Milwaukee Hears Nylon Properties Described

Marvin C. Stowe

The Milwaukee section of the Society of Plastics Engineers held its March meeting on March 9, 1954. The meeting attended by 80 men got underway with a social hour. Then after a wonderful feast, a short business meeting, and an introductory speech by our President Mr. George Stein we had the pleasure of hearing from Mr. Bailey Barnes, Polychemical Department, Du Pont Company.

Mr. Barnes covered the properties and molding techniques of Nylon. He had color slides to illustrate each point as he went along. These slides were also very helpful in showing the various pieces that have been molded of Nylon. Mr. Barnes explained how Nylon has in many cases cut costs and has done a superior job over former materials used.

One of the more popular uses of Nylon is in the manufacturing of gears. Some advantages here are its flexibility, non-lubrication quality, and silent operating. We should never overlook the strength of Nylon which gives it long life. The textile industry has answered many of their problems with Nylon. The molding complications of Nylon have been modified, the material costs are competitive, and the economy of Nylon is terrific.

After Mr. Barnes covered quite thoroughly the past, present, and future of Nylon, questioning and open discussion took place. An examination of the actual Nylon molded parts was also enjoyed.

One could actually write a book on the practical knowledge received from this lecture. I shall make this suggestion that any section of the Society of Plastics Engineers not having as yet had the opportunity to enjoy this lecture should schedule it in the not too distant future.

Plastisol Patent

W. D. Todd's article Vinyl Fast Resin Dispersions appeared in the SPE Journal for March. Of interest to readers on this topic is the patent granted to E. H. Schwencke, Jan. 12, 1954; U.S. Pat. 2,666,036.

Plastics Face Real Challenge Says Ruddock At Newark

D. J. Mullins

Speaking at the March meeting of the Newark Section, Amos Ruddock, Manager Merchandising Section, Dow Chemical Company acclaimed the S.P.E. as being a potent factor in the plastics industry and an organization which may be relied on for guidance and counsel.

Although plastics are here to stay, they are becoming synonymous with cheap and shoddy items and some advertisers make it a point to emphasize their articles are not plastic, according to Mr. Ruddock. He pointed out that a recent editorial in a Chicago newspaper criticized the quality of plastic toys and that a national weekly magazine contained an article advocating importation of toys from Japan because plastic toys are of doubtful value. Mr. Ruddock suggested that molders, particularly those in the thermoplastics industry, join together and concentrate on more quality backed up with a strong merchandising and selling program geared to education of the consumer. To emphasize this point, Mr. Ruddock stated that the manufacturer of any single brand of soap spends more advertising money per annum than the entire industry spends collectively for its various products.

The plastics industry is suffering from the failure of engineers to accept their rightful role in marketing; there would be no shoddy merchandise on the market unless some engineer compromised his values, Mr. Ruddock said.

Mr. Ruddock urged plastics engineers to work within their companies and the industry to promote standards; to guide merchandising people, since selling and engineering cannot be rightfully separated; to approve and revise advertising copy before it is released to guarantee truth and integrity. In addition, Mr. Ruddock called for group action from the S.P.E. by the formation of committees to study this matter.

Other guest speakers were Lois Stevens, Assistant advertising Manager, Plastics Division, Celanese Corporation of America and Harriet Raymond, Advertising and Sales Promotion Manager, Plastics Division, Celanese Corporation of America. Miss Stevens exhibited various fabrics that achieve function and fashion through blending of natural fibers with acetate fibers. Miss Raymond emphasized the role which the plastics industry plays in the eyeglass field and she exhibited colorful spectacle wardrobes which were created to provide eyeglasses to fit the occasion.

California Hears About Plastics in Guided Missiles And Airplane Construction

Walter H. Kadlec

A discussion of the advancements in the application of reinforced plastics to aircraft and guided missiles was presented to the March fourth meeting by Mr. Wm. E. Braham. As vice-president in charge of engineering at Zenith Plastics Company, Gardena, Mr. Braham was able to outline the progress of the low-pressure laminating industry by tracing the history of his own organization now the largest of its kind in the country. The fabrication of ducts from polyester resin and glass cloth in 1946 has led to the construction of super-radomes that would crowd a two-car garage. The procedures were well illustrated in a thirty minute movie produced by a local oil company for its TV program "Success Story." The film very adequately served as a tour of a plant that covers 175,000 square feet and employs close to one thousand people.

Following the film presentation, Mr. Braham discussed recent material developments with particular attention to guided missiles. Increasing use of reinforced plastics for exterior surfaces and fuselage sections poses a problem of heat resistance as projected speeds approach the thermal barrier. The search is now directed toward resins with higher heat limits and greater resistance to erosion from the elements. Combinations being tested include silicones and related resins plus asbestos for fiber reinforcing, the latter an English development recently introduced in this country.

All possibilities are examined, some because of the advantage of slow thermal transfer rates in comparison to metals that have good strength-space ratios. Comparable strength-weight ratios can be achieved in plastics but usually at the sacrifice of space needed for vital equipment. Mr. Braham closed by starting that progress is being made through the combined efforts of the material suppliers and processors. During the discussion period which followed, Mr. Braham was assisted by Zenith engineers, Norb Meyer and Wally Fink.

Seventy-five members and guests attended the dinner meeting which was preceded by a cocktail hour. The Southern California Section invites out-of-town guests to attend our meetings which are held at Scully's Restaurant the first Thursday of each month.

New Industrial Hydraulic Control Bulletin Published by Pantex

Explaining many outstanding advantages, the Pantex Manufacturing Corporation of Pawtucket, R. I., has just released a new six-page folder on their line of Remotely Controlled, ¾" Pilot Operated, 4-Way Valves for industrial use. They have a pressure range from 100 to 5000 P.S.I.

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One of the pleasant parts of any job is to say, "It is completed". Perhaps there is nothing more nerve-racking than that [illegible] interminable wait between the time an order is received and the time when all parts are shipped. This is especially true [illegible] new tools are involved. The customer would often be much surprised to know the amount of discussion going on behind the [illegible]

[illegible] Marcuslav said, "MEN ARE NEVER SO LIKELY TO SETTLE A QUESTION RIGHTLY AS WHEN THEY DISCUSS IT [illegible]". One problem is to keep it a DISCUSSION and not an ARGUMENT. Another problem is to keep the discussion to the [illegible] and not fall into the trap the Latin describes as "ignoratio elenchi".

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Wayne I. Pribble

[illegible] will award $5.00 to the first person sending a reasonably correct interpretation of the Latin phrase (we'll be the judge [illegible] winner).

Applications of Polystyrene

(continued from page 39)

Some "high impact" modified material having lower thermal shrinkage has been used in television tube masks. The heat problem to date on this application has not been too troublesome, nevertheless, it just makes good sense to use this free insurance for heat problems by using the best materials available for television masks.

At present these modified low thermal shrinkage polystyrenes are being used and are under consideration for a number of classified military applications.

Currently, there is a photostatic type copying machine on the market which uses 15 pounds of "high impact" type low thermal shrink modified polystyrene per unit. The material was selected because of its shock resistance and ability to withstand the heat of the light bulbs in the printing compartment.

Component parts of a commercial automobile windshield washer are made from the "medium impact" low thermal shrink material. Here again, good dimensional stability—low water absorption and non-swelling characteristics as well as resilience and ability to withstand auto engine heat without deformation—is important.

FUTURE APPLICATIONS

First of all, we anticipate a more or less complete changeover of radio cabinets from regular polystyrene to these materials. Also, as color television becomes more and more a commercial reality, it appears that more heat resistant non-brittle plastics will be required. This will be necessary to provide adequate service when plastic parts are subjected to the additional heat generated by the increased number of electrical components necessary for color as compared to black and white television receivers.

More and more housewares would benefit by the combination of toughness and low thermal shrinkage to overcome public reaction against brittle plastics which deform easily. The prudent designer and manufacturer is beginning to realize that he must use the best and most suitable materials if he is to keep his markets.

The entire air-conditioner cabinet, as well as the grill section, is a possible application for these materials. As improvements are made in weathering resistance, it may be possible to make even the section which projects outdoors from materials of this type.

The appliance field, particularly housings, handles, bases, reservoirs, nozzles, tubes and many other items has yet to be fully explored. The use of low thermal shrink modified polystyrenes could very well bring about hitherto impossible styling as well as lower cost.

One of the most rapidly expanding fields today is fluorescent lighting. Heavy metal and glass reflectors, baffles, and end caps will doubtlessly be replaced by the tougher, low shrink modified polystyrenes.

The packaging field offers a good outlet for large quantities of these materials. Weight saving, toughness and thermal stability in shipping and on display are attributes constantly sought here. Only one deformed plastic object in a store window can injure plastic products sales for all customers who see it.

Camera cases must be rugged and durable. At the same time, they require resistance against heat deformation if they are to withstand the summer heat on the rear ledge of an automobile or in its glove compartment. Although this resistance is available in these low thermal shrink modified polystyrenes, very little advantage has been taken of these properties, in this application to date. However, expansion along this line appears imminent.

In conclusion one thought should be remembered; namely, that these are **new and useful materials** which can open the way to new profitable products, for those who desire to produce and sell plastic products of the highest quality and durability.

Automatic Injection Molding

(continued from page 16)

A mold design is of utmost importance in automatic molding. Many molds are in operation where the parts are automatically degated on the opening of the mold. In this case, gates and runners can be automatically sorted from the finished molded pieces. Molds must be very accurately made, cavities well polished, all undercuts must be eliminated making it possible for positive ejection of the parts. Knockout pins should be strategically located and in many cases, a stripper plate can be used to very good advantage in ejecting the parts.

SPRUELESS MOLDING

Fred Means, manager of the plastic machine division of Fellows Gear Shaper Company, wrote an interesting article for the *SPE Journal* in November 1952. In this article he illustrated a nozzle brought into the part line of a mold with a very short tapered sprue bushing.

The writer has recently concluded an experiment whereby no sprue bushing what-so-ever was used.

On a twenty cavity ring-gated mold producing little plastic leaves, the sprue bushing was completely removed. (Refer to Photograph "C", Shot No. 9). A special nozzle with an extension one inch in diameter with a flat end was installed in the machine. The end of the nozzle extended to the part line of the mold. (See sketch No. 3). The one inch diameter was relieved directly back of the end of the nozzle 3/32 of an inch to eliminate cooling transferring from the cold mold plate to the nozzle. The nozzle had approximately a 5/32 inch diameter opening. This opening was tapered for 3/8 of an inch. The rest of the nozzle was of standard construction. The nozzle itself had a heating band within approximately 1/2 inch of the end.

This mold had been run with a conventional nozzle (See Sketch No. 4) just prior to this experiment. The three pyrometers were set as follows: 445° for the rear pyrometer, 440° for the front pyrometer and 445° for the nose pyrometer. Oil pressure was set at maximum of 1250 psi. The machine was operating on a 4-1/2 second cycle, producing 800 finished shots per hour or 16,000 molded pieces per hour. The experimental nozzle was installed in the machine and the machine started up. The oil pressure was maintained at 1250 psi. An injection cylinder temperature of 400° on the rear, 400° on the front and 380° on the nozzle was realized.

The advantages of this nozzle set up are many fold. By injecting plastic at lower temperatures, less strain occurs, better dimensional stability is maintained. The material, not being so hot, requires a shorter cure. Possibility of flashing is considerably reduced and sprue waste is eliminated. On many parts where the machine is not operating at near top speed, production can be greatly increased.

This experiment was conducted on a Moslo model 73 fully automatic two ounce machine. We have run this shot as fast as a 3-1/2 second cycle or 1025 shots per hour which would produce 20,500 finished molded pieces in one hour. This gives you an excellent idea of the potential of fully automatic injection molding. Frankly there aren't too many parts that can be run at this [illegible]

...but there are definitely some thin wall jobs that can be produced this rapidly.

...ome other parts produced on high speed automatic plastic injection molding machines are shown in Photograph "D", shots No. 10 & 11. Part #10 was molded from nylon on a Lester 4 ounce machine by General Motors Corportation. The cycle was 25.7 seconds or 140 shots per hour. The weight is 34.6 grams.

Part #11 was molded from nylon on a Lester 8 ounce machine, 18 second cycle, 200 shots per hour. The weight is 65.8 grams.

The chair tips (Refer to Photograph "E", Shot No. 22) were made from polyethylene on a Moslo 4 ounce machine, in a 20 cavity mold. The weight per shot is 5-½ ounces, which proves that some machines can shoot more than the rated capacity. The part was made by the A.S.K. Manufacturing Company, Philadelphia, Pa.

There is a lot that the manufacturer of automatic plastic injection molding machines, the molder, and the mold maker must learn. This phase of the plastic industry is definitely in its infancy. With the interchange of ideas among us, I am sure that better equipment and better molds can be built, making it possible to produce better parts at a lower cost.

I feel that in time to come, plastic injection machinery manufacturers, with your cooperation, complaints and ideas, will produce a better and more successful fully automatic plastic injection molding machine.

Let's look ahead into the future and I will try to describe the type of machine that you would all like. First of all, the machine should be streamlined and look like a Cadillac. However, it should be very small in size so that it doesn't take any large amount of floor space. It should be fully automatic, far beyond our present interpretation of this word. A molder should be able to line up twenty to thirty of these machines and be able to sit at the end of this line in an "easy chair," with a good comfortable foot stool to rest his feet on. With an automatic control panel that will control all of these machines, with a flick of a switch the mold cavities can be changed. With the turn of a knob, color shades are produced to suit the customer's wish. The parts, of course, are all automatically degated and automatically packaged and labeled, ready for shipment.

All of the manufacturers of automatic plastic injection molding machines are working violently on this project. I think by the year 2025, we will have it completed. Unfortunately, I don't think that any of us is going to live to see the day.

Getting back to the more serious side, automatic injection molding is here to stay and I am sure that any of the manufacturers building this equipment would be very happy to hear from you on any suggestions or questions that you might have.

Cyanamid Literature

An up to date review of American Cyanamid Company's literature on some of the new products being marketed by the firm for trial use has been published and is now available. "New Product Bulletin, Collective Volume III," a 159-page booklet, offers detailed technical data on Acrylamide; 3-Aminopropanol; N-tert-Butylacrylamide; N, N-Diallylmelamine; Guanamines; 3,3'-Iminobispropylamine; N,N'-Methylenebisacrylamide; Potassium Diisopropyl Dithiophosphate; Surface Active Agents TR and BPE; and Triallyl Cyanurate.

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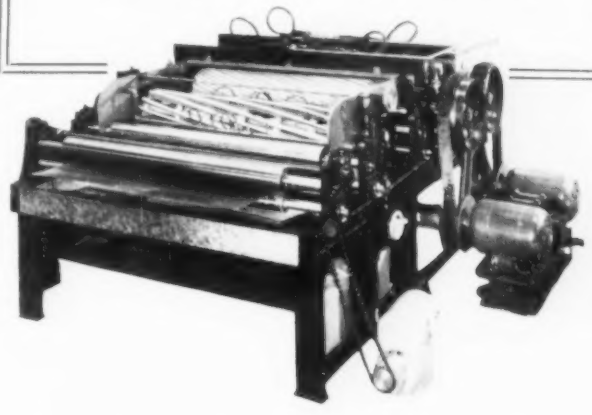

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Philadelphia Hears Talk On Rigid PVC

H. C. Colby, Jr.

The use of unplasticized polyvinyl chloride as a corrosion resistant material of construction was the topic at the March 23rd meeting of the Philadelphia Section of SPE. Mr. B. K. Lyckberg, Technical Manager of Chemicals, and Mr. J. R. Bukey, Manager Sales Service Laboratories, both of The Firestone Plastics Company, Division of the Firestone Tire & Rubber Company, were the speakers. Mr. Lyckberg's portion of the talk was mainly devoted to the history of the use of unplasticized polyvinyl chloride, while Mr. Bukey concentrated on present domestic uses.

"Throughout the years corrosion has been one of the major problems in plant design and plant maintenance. Until the birth of the plastics era, little advancement was made in the control of the ravages of corrosion and chemical attack. One of the more important plastic materials of construction is unplasticized polyvinyl chloride.

Vinyl chloride resins were developed in Germany during the early 1930's and brought to this country a few years later. Although PVC under the names of Vinidur and Lucoflex has been used rather extensively for industrial chemical installations since 1935, its development in this country has been slow, probably due to the rapidly expanding markets in plasticized vinyl resins which grew from 1,000,000 pounds in 1940 to over 350,000,000 pounds last year.

In Western Germany over 10% of PVC production goes into rigid applications today. During the war they found many applications in the chemical industry where hard PVC could be used in place of stainless steel, and in 1944, 60,000,000 lbs. were used. For example, concentrated HCl has been handled for 18 years in a 2½" pipe outdoors, piping storage tank and ducts have been in service for 15 years on 15% H_2SO_4 fuming HNO_3 has been stored in a tank 10 feet for 5 years and AlCl gas has been carried in an outdoor duct for 11 years.

There are many chemical industries where successful installations have been made. They involve:

1. Rayon plants (textile)
2. Steel (pickling tank covers)
3. Electroplating
4. Photographic equipment
5. Food industry
6. Leather tanning
7. Paper making
8. Water treating
9. Soap industry
10. Oil refineries
11. Agricultural chemicals
12. Miscellaneous chemical plants

Unplasticized polyvinyl chloride, more commonly referred to as unplasticized PVC, is applied in general to polyvinyl chloride compounds of substantially pure polyvinyl chloride resin in which only the minimum amount of stabilizer for processing is used. The optimum physical and chemical properties are obtained in unplasticized PVC.

The development of unplasticized PVC has at last given the engineer a new material of construction which has sufficient **workability, structural strength, impact resistance,** and **hardness to replace metals in many forms.** At the same time, unplasticized polyvinyl chloride offers such inherent properties as **extreme corrosion resistance, dimensional stability, low maintenance, ease of fabrication,** light **weight, good aging, excellent electrical resistivity,** and **good** heat **insulating properties.**

The chemical resistance of unplasticized PVC toward aqueous inorganics is excellent. Strong and dilute acids and alkalies show no attack at 75 F. It may generally be said that resistance decreases somewhat with heat especially above 160 F. The behaviour of unplasticized PVC in contact with organic chemicals is excellent in most cases; however, it is severely attacked by some organi-

(please turn to page 51)

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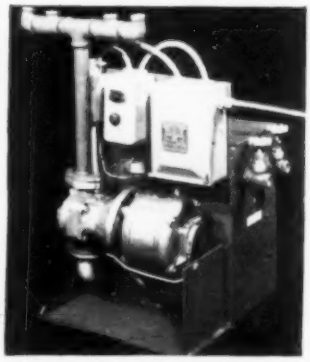

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Southeastern Ohio Hears Interesting Talk On Vinyl Plastisols

William J. Stranathan

The Southeastern Ohio Section of Society of Plastics Engineers had 30 members and guests attending the March meeting to hear the speaker of the evening give a very interesting talk on Vinyl Plastisols.

Mr. Walter J. Kaufman of Watson Standard Co., Pittsburg, Pa. was introduced by Program Chairman, George Edwards of Ohio Plastic Co., Frazeysburg, Ohio.

Mr. Kaufman stated that vinyl plastisol was first used in Marine cable repair in 1944, and has been on the rise ever since with very extensive research and study. Plastisol dispersions contain no solvents and therefore can be considered 100% solids. They can be varied in their viscosity from smooth and free-flowing to a heavy paste like material. Plastisol dispersions can be dipped or slush molded and also by a relatively new process called Rotary Molding. He stated that Plastisols are more versatile in these types of molding as it contains no solvent to be entrapped.

The construction of the mold is of the serious concern and from the samples produced by Mr. Kaufman many intricate objects can be produced.

After dipping a mold into a plastisol, fusion can be accomplished by the use of hot air or infra-red heat. They can also be fused by dipping the mold in a suitable liquid bath between 325 and 350 F. This fusing changes the Plastisol into a rubbery elastic film. The same technology of fusing is applicable to slush and rotary molding. After fusing the mold is cooled in cold water then the vinyl coating can easily be removed.

Doll heads are a typical example of molded vinyl plastisols. This is only one of hundreds of different uses.

Molds for these Plastisols can be easily manufactured from aluminum castings or machined from steel. Mr. Kaufman also explained an electroplating process for producing molds with intricate detail.

Many questions were answered concerning the principle topic and an interesting discussion period followed the talk on Vinyl Plastisols.

A chicken dinner and business session in charge of Pres. John Chomicz of General Electric Co., Coshocton, Ohio preceded the talk by Mr. Kaufman. Membership was the main topic of discussion and several ideas on obtaining new members were discussed.

Eleven companies were represented at the meeting. Let's keep up our good attendance. "It" keeps up your section.

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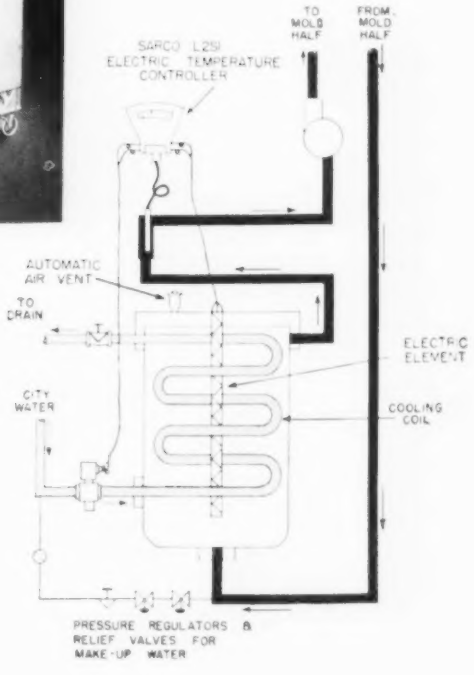

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Our New Fully Automatic Model "H" THERMOLATOR takes over complete responsibility for adding heat to, or draining heat from each side of the mold. Large minivolt Pyrometer Scales and Pilot Lights on remote control Panel give Supervision easy visual check on mold operating conditions. Designed for and used by large plants in streamlining operations.

THERMOLATOR*

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MOLD TEMPERATURE CONTROL

Write — for literature and information on both Portable (Illustrated), and Fully Automatic Models.

Industrial MFG. CORP.

Specialists in Industrial Heat Transfer by Liquids

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Styrene-Acrylonitrile Copolymers

(continued from page 33)

In the preferred extrusion of acrylonitrile-styrene copolymers, the rear sections of the extruder are operated at lower temperatures than are used in the forward end. This is done to minimize the danger of molecular breakdown and discoloration which may occur when these resins are subjected to long exposure at elevated temperatures. The surface finish of the extruded product depends upon the temperature of the head and die sections; therefore, a careful temperature control must be kept on these sections. If the die is too cold, the extruded surface may be rough and uneven and the product will have a cloudy appearance. A temperature in excess of that needed will cause the plastic mass to be non-uniformly heated, resulting in a scaly surface and pronounced die lines.

Sometimes the extrusion characteristics of C-H may be further benefited through the use of high worm speed while maintaining a high head resistance. By these means, more heat is supplied to the plastic mass through mechanical working than by external heating sources. The result is a more uniformly heated plastic mass having less tendency to stick to the worm.

The use of a breaker plate and screens are recommended for extrusion. A typical combination is a 20-2[illegible] mesh stainless steel screen paired with 60-mesh stainless steel screen. In this arrangement, the coarser screen is used as the reinforcing member and is positioned directly against the breaker plate with the finer screen atop it. For improved dimensional uniformity in the finished product, a screen as fine as 150 mesh may be substituted for the 60-mesh screen. The finer mesh screen, however, tends to decrease throughput rates.

CLASSIFIED ADS

DRAFTSMAN—MOLD DESIGNER

Excellent opportunity with growing plastic tooling company. Give full details, experience, background and salary. Replies held in strictest confidence. CACO, INC. 1193 W. 2nd Street, Pomona, Calif.

PLASTICS ENGINEERS—For Development of Practical Application of Laminates. This position has been created in a large and diversified organization on the East Coast to pioneer a relatively new field. The man selected will head a program to develop laminates to commercial needs. It requires someone familiar with the techniques of fabricating extremely large objects needing reinforcement for required strength, as well as considerable experience in the development of laminated polyesters. Our salary offer is exceptionally high, and in addition we have a liberal pension plan, an accumulative vacation policy, executive insurance and many other employee benefits. We will assume the expense incurred by traveling and moving to this area. Please write details of experience, education, salaries received and initial salary requirements. Complete privacy is guaranteed. Our personnel know of this opening. Box 327, Room 1201, 230 West 41 St., New York 36, N. Y.

SALESMEN WANTED

To sell complete line of urea and phenolic resins, and phenolic molding compounds. All correspondence treated in confidence. Reply Box 1454, SPE Journal, Security Bank Bldg., Athens, Ohio.

Philadelphia

(continued from page 52)

materials. Most aldehydes, ketones, esters, ethers, and chlorinated hydrocarbons will attack unplasticized PVC. Other organics cause less severe swelling but subsequent weakening. Long chain hydrocarbons and high hydroxyl content compounds have little or no effect on the unplasticized polyvinyl chloride.

Today the plastic industry in the United States has surpassed all other countries, not because of lack of the classical materials used before, but because of the conviction that new and better materials have been created. Unplasticized PVC is rapidly receiving recognition and acceptance by our construction and chemical engineers as an excellent corrosion resistant material of construction."

The technical talks were preceded by a short business meeting at which the committee chairmen for the 1955 National Conference were present. They are: Chairman, Adolph Kissileff, Amplex Mfg., Co.; Co-Chairman, George Koch, Jr., Oak Engineering Co.; Honorary Chairman, Dick Bishop, Foster Grant Co.; Secretary, Ed Fitzpatrick, F. J. Stokes Co.; Treasurer, Henry Darlington, Jr., A. H. Wirz Co.; Liason and Publicity, C. C. Davies, Stokes Trenton, Inc.; House Committee, Ed Dennis, Penn Plastics; Program Committee, Wm. Bracken, Hercules Powder Co.; Registration Committee, Don Varty, Rohm and Haas. Committee members were also listed and more volunteers requested. You see, we're already working for you to come on down and join us in Atlantic City. Remember—SPEAC—'55.

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Something New for Extruders -from Egan

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National Plastics Exposition

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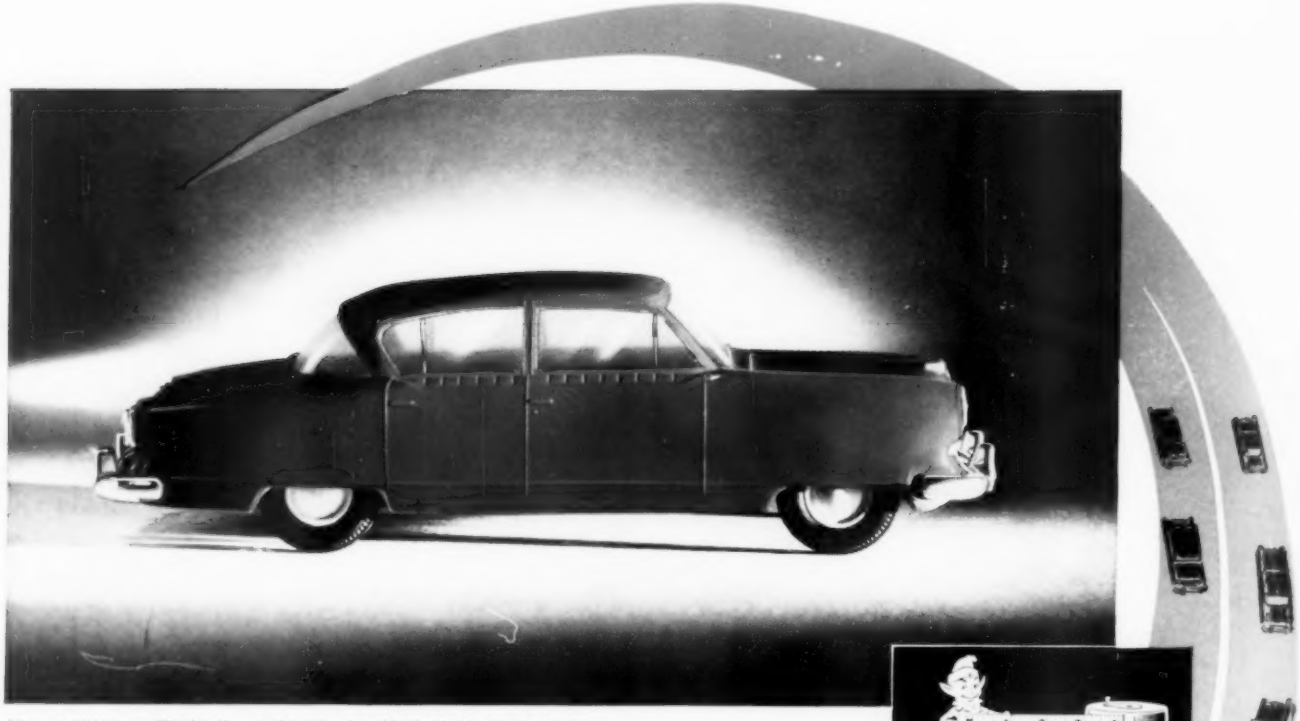
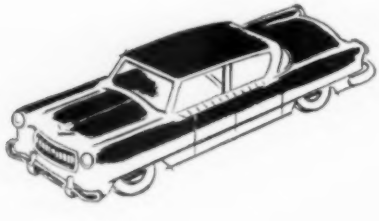
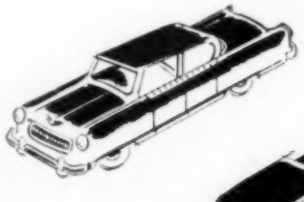
FOR TOYS ON THE MOVE

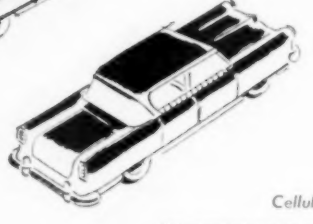


Loaded with "extras", Product Miniature's new Nash Ambassador has white-wall wheels with black rubber tires, "Solex" tinted glass windows, die-cast chromed wrap-around bumpers, grille, and headlights, is powered by a strong spin-torque motor. Thick-walled, warpproof assembly makes it virtually unbreakable. One of twelve exciting new mechanized toys in the new Tru-Miniature line . . . all molded with Hercocel (cellulose acetate).

Molded with supertough Hercocel, this authentic scale model of the 1954 Nash has action and attraction galore . . . greater play value, longer play life. Toy buyers have learned that there's no substitute for versatile Hercocel, the durable low-cost *quality* plastic.







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